Intrapartum Fetal Monitoring and Its Correlation with Umbilical Cord Blood pH and Early Neonatal Outcome: A Prospective Cohort Study

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ABSTRACT

Aim: Intrapartum fetal hypoxia leads to neonatal morbidity and mortality. Though cardiotocography (CTG) plays an important role in detecting fetal hypoxia, it has high false-positive rate and is a poor predictor of acidosis. Umbilical artery pH identifies infants at risk for hypoxia and better predicts neonatal outcome. Hence the study was done to correlate nonreassuring CTG findings with umbilical artery pH and neonatal outcome.

Materials and methods: The study included 255 pregnant women in labor with nonreassuring CTG. The findings were categorized as suspicious and pathological. Umbilical arterial cord blood analysis was done in all newborns. The umbilical arterial cord blood pH of <7.2 was defined as fetal acidosis. The correlation between CTG findings, cord blood pH, and neonatal outcome was recorded.

Results: In the study, among 255 women, 54.9% had suspicious and 45.1% had pathological CTG. The rate of cesarean section, Apgar score, was similar in both the groups. Subjects with pathological CTG had more babies with low cord pH compared to suspicious CTG (62.6 vs 26.4%). 55% of babies with pH <7.2 needed neonatal intensive care unit (NICU) admission compared to 11.6% with normal pH. Babies born with pathological CTG and low cord pH were more likely to have NICU admission and other morbidities.

Conclusion: Detection and management of fetal compromise at the earliest is of utmost importance. Though cardiotocography is a simple test to analyze fetal condition, it is a good practice to analyze umbilical cord blood pH to find neonates with acidosis and prevent complications.

Clinical significance: The umbilical artery pH is a good predictor of adverse neonatal outcome and is a useful tool for screening newborns at risk. Also an umbilical cord pH less than 7.2 can be used as a prognostic factor for prediction of neonatal outcome. Our study is one of the very few studies that compare CTG findings based on National Institute for Health and Care Excellence (NICE) guidelines with umbilical artery pH and neonatal outcome.

Keywords: Cord blood pH, CTG, NICU, Nonreassuring.

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INTRODUCTION

Intrapartum hypoxia leads to fetal asphyxia, acidosis, neonatal neuronal injury, long-term morbidity, and death.[1] Hence intrapartum fetal monitoring is done to identify the early signs of fetal hypoxia and to take the necessary steps at the earliest in order to prevent the sequelae of fetal hypoxia.

Intrapartum electronic fetal monitoring with cardiotocography has become a necessary part of every labor. Edward Hon pioneered this in the late 1950s in the USA.[2] Electronic fetal monitoring records the fetal heart rate pattern and its relationship with uterine contractions.[3]

Though a normal CTG is reassuring, an abnormal CTG does not always indicate fetal acidosis. CTG has a high false positive rate and is a poor predictor of fetal hypoxia and metabolic acidosis.[4] Consequently a good perinatal outcome is expected when CTG results are normal but poor outcome may not occur always when they are abnormal. Also, there is a high intra- and interobserver variation in the classification and interpretation of CTG.

It is important to recognize neonatal acidemia as these neonates are at risk of unfavorable outcome after delivery. These outcomes include low Apgar scores, respiratory distress syndrome, hypoxic ischemic encephalopathy, seizures, intraventricular hemorrhage, sepsis, and death.[5]

When CTG was introduced, it was thought that it would reduce the incidence of cerebral palsy and mental retardation by 50%. But trials have shown little or no benefit in long-term neurological outcome.[6]

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So, umbilical artery pH analysis is a better method in the prediction of neonatal outcome. It provides important information about the fetuses exposed to intrapartum hypoxia and helps to identify the infant at high risk for hypoxic events and related complications.

Acidosis is a measurable outcome in the newborn and is commonly defined as a low umbilical pH or a high umbilical base deficit, which is expressed as negative base excess. The normal range of umbilical cord pH is 7.40 ± 0.20.[6] The cut-off of low umbilical pH (metabolic acidosis) varies from 7.2 to 7.0[1] and a base deficit of ≥12.0 mmol/L.[6]

The American College of Obstetricians and Gynecologists states that umbilical cord blood gas analysis should be performed after any delivery in which a fetal metabolic abnormality is suspected.[7]

Hence the present study was done to correlate nonreassuring CTG findings with umbilical cord arterial pH and the neonatal outcome.

MATERIALS AND METHODS

The aims and objectives of this study were to correlate nonreassuring CTG findings with umbilical arterial blood pH and to find the neonatal outcome.

This was a prospective cohort study conducted at Father Muller Medical College Hospital, Mangaluru, from September 2018 to December 2019. The ethical committee of the hospital approved this study.

The study included 255 women in labor with nonreassuring CTG.

The sample size was calculated using the formula:

$$N = Z\alpha^2 p(1 - p)/e^2$$

$p = 79\%$ (sensitivity)
$Z\alpha = 1.96$ at 95% confidence interval
$e =$ allowable error, $e = 5\%$
$N = 255$.

A sample of size 255 was included in the study with 95% confidence interval.

Singleton pregnancies with gestational age more than 34 weeks in cephalic presentation were included in the study.

Women with gestational age less than 34 weeks, subjects undergoing elective cesarean section, those with multiple pregnancies, malpresentations, and anomalous fetuses were excluded from the study. A written consent was taken from all the subjects participating in the study. Maternal demographic profile, obstetric history, risk factors, and relevant details were noted.

All women were subjected to CTG in the active stage of labor with the paper speed at 1 cm/minute.

CTG was assessed objectively by the NICE guidelines and were categorized as normal, suspicious, and pathological. Women with suspicious and pathological CTG were included in the study.

A CTG was considered normal when all the features were reassuring. It was categorized as suspicious when there was one nonreassuring feature and two reassuring features. A CTG was pathological when there was one abnormal feature or two nonreassuring features.[8]

Monitoring was continued till delivery. Steps were taken based on the CTG findings and stage of labor. Progress of labor, mode of delivery, and fetal outcome were assessed.

A 10–20 cm segment of cord was clamped immediately after delivery using two clamps near the neonate and two clamps near the placenta. Arterial blood was drawn from this isolated segment into a 2 mL syringe previously flushed with 1000 µ/mL heparin solution. The syringes were immediately transported to the laboratory in ice. Analysis was done immediately. The umbilical arterial cord blood pH of <7.2 was defined as fetal acidosis.[1] Early neonatal outcome in terms of Apgar score, need for neonatal resuscitation, admission to NICU, neonatal seizures, intracranial hemorrhage, hypoxic ischemic encephalopathy, neonatal sepsis, and others were noted. The correlation between CTG findings, cord blood pH, and neonatal outcome was recorded. Statistical analysis was performed using SPSS for windows version 2.0.

RESULTS

In the study, among 255 women with nonreassuring CTG, 140 (54.9%) subjects had suspicious and 115 (45.1%) had pathological CTG.

Age-group: The subjects were in the age group of 20–35 years.

Parity: Majority were primigravida (72%) and remaining were multigravida (28%).

Mode of delivery: Among 140 mothers with suspicious CTG, 32 (22.8%) had normal delivery, 21 (15%) had instrumental delivery, and 87 (62.2%) had cesarean section. In the pathological CTG group, among 115 women, 21 (18.3%) had normal delivery, 10 (8.7%) had instrumental delivery, and 84 (73%) had cesarean section. There was not much difference in the mode of delivery between the suspicious CTG group and the pathological CTG group and was not statistically significant (Chi-square 3.825, *p*-value 0.147) (Fig. 1).

Apgar score: The 5-minute Apgar score was similar in both the groups with suspicious and pathological CTG. Thirteen subjects (9.3%) in the suspicious CTG group and 19 (16.5%) in pathological group had 5 minute Apgar score less than 7 whereas 127 (90.7%) in the suspicious CTG group and 96 (83.5%) in the pathological CTG group had Apgar score more than 7 at 5 minutes. The difference in the 5-minute Apgar scores between the suspicious and pathological CTG groups was not statistically significant.

Correlation of umbilical cord arterial blood pH with CTG:

Among the subjects, those with pathological CTG had more babies with low cord pH compared to babies born with suspicious CTG.

In babies born with pathological CTG, 51.3% had pH 7–7.2 and 11.3% had pH <7 compared to those with suspicious CTG where 25% had pH 7–7.2 and 1.4% had pH <7. Remaining 73.6% of them with suspicious CTG had pH >7.2 which was statistically significant (Table 1).

Correlation between CTG findings and NICU admission:

Among babies born to mothers with suspicious CTG, 22.14% needed NICU admission as against 40% babies born to mothers with pathological CTG. New-borns of mothers with pathological CTG had significant risk of NICU admission when compared to mothers with suspicious CTG.

The increased admission to NICU of babies born with pathological CTG was statistically significant (Table 2).
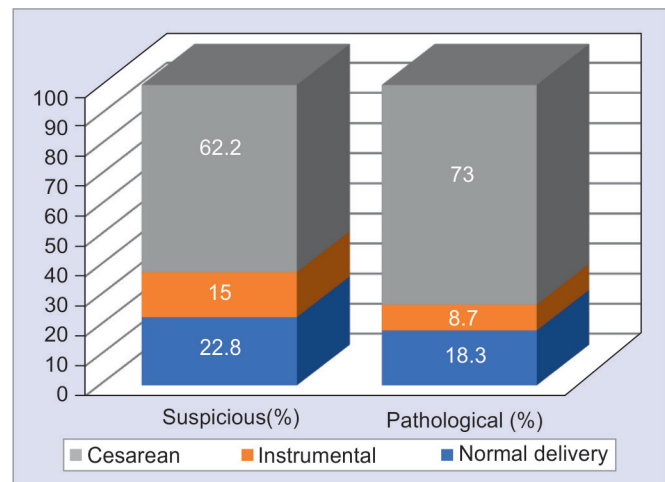

Fig. 1: Mode of delivery

Correlation between cord blood pH and NICU admission:

Among babies born with pH <7.2, 55% needed NICU admission as against 11.6% babies with normal pH. Lower the pH, higher was the chance of babies needing NICU admission. This was statistically significant (Table 3).

Comparison between CTG and cord pH among babies admitted to NICU:

Babies born with pathological CTGs and low pH were more likely to have NICU admission (statistically significant p <0.001) and other morbidities compared to babies with suspicious CTG and normal pH (Fig. 2).

Table 1: Cord blood pH correlation with CTG

pH	Suspicious CTG	%	Pathological CTG	Percentage	p value
<7.0	2	1.4	13	11.3	Chi-square = 36.75
7–7.2	35	25	59	51.3	p value = 0.001
>7.2	103	73.6	43	37.4	(significant)
	140		115		

Table 2: CTG findings and NICU admissions

CTG findings	NICU admission	Percentage	p value
Suspicious (n = 140)	31	22.14%	Chi-square = 5.131
Pathological (n = 115)	46	40%	p value = 0.024 (significant)
Total (N = 255)	77	30.2%	

NICU, neonatal intensive care unit

Table 3: Cord blood pH and NICU admission

pH	NICU admission	Percentage	p value
Normal pH (>7.2) (n = 146)	17	11.6%	Chi-square = 20.18
Abnormal pH (<7.2) (n = 109)	60	55%	p value = 0.001 (significant)
N = 255	77	30.2%	

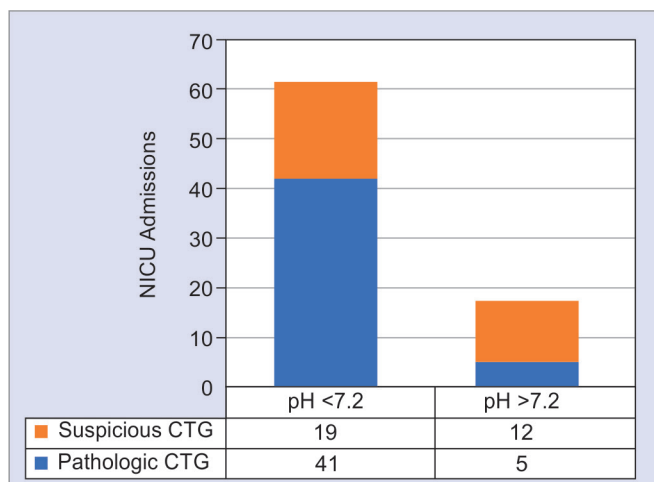|	pH <7.2	pH >7.2
Suspicious CTG	19	12
Pathologic CTG	41	5

Fig. 2: Comparison between CTG, cord pH among NICU admissions

Neonatal outcome in normal and abnormal umbilical cord pH groups:

Neonatal morbidities like the need of neonatal resuscitation need of CPAP (continuous positive airway pressure) or mechanical ventilation, neonatal seizures, respiratory distress, persistent pulmonary hypertension (PPHN), renal failure, necrotizing enterocolitis, neonatal sepsis, and mortality were higher and statistically more significant in neonates with abnormal cord pH (Table 4).

The difference in neonatal outcome among newborns born to mothers with suspicious or pathological CTG was not statistically significant (Table 5). Comparing Tables 4 and 5 it is clear that cord blood pH is a better predictor of neonatal outcome than CTG findings.

As the cord blood pH decreases, the chance of having adverse neonatal outcome increases.

DISCUSSION

This was a prospective observational study of 255 women in labor with nonreassuring CTG findings.

The cord blood pH is considered to be a definitive test for fetal evaluation. pH along with lactate are parameters to distinguish normal babies from acidotic neonates.[9]

In the present study, 62.2% of those with suspicious CTG and 73% with pathological CTG had cesarean section. This was similar to the study by Banu[10] where 73.9% of those with suspicious CTG and 81.8% with pathological CTG underwent cesarean section. But among them, only 20.5% neonates with pathological CTG needed resuscitation suggesting that though CTG may show abnormalities, all may not need resuscitatory measures. In our study, 30.2% of the newborns with nonreassuring CTG needed NICU admission.

In the study by Ray and Ray,[11] the mean cord blood pH was 7.253 ± 0.07. With a pH of 7.2 as the cut-off for metabolic acidosis, 18.3% of neonates were found to be acidotic. They also found that among subjects with abnormal intrapartum CTG, 52.5% had acidosis and hence a statistically significant association was found between intrapartum CTG and umbilical cord arterial pH.

This was comparable to our study as 26.4% of neonates with suspicious CTG and 62.6% with pathological CTG had low pH of <7.2.

This was also comparable to the study by Aboulghar et al. where they found acidosis in 50% cases with pathological CTG and in 19.2% cases with suspicious CTG thus concluding that pathological rather than suspicious CTG significantly increased the risk of abnormal cord blood pH.[12]

In the study by Abbasalizadeh et al., 38.9% of infants with nonreassuring CTG patterns had pH less than 7.2 and the remaining 61.1% infants had pH more than 7.2. All infants were discharged in good health.[4]

Indiramani et al. in their study found NICU admission rate of 55.9% in neonates of mothers with abnormal CTG pattern as against 1.7% in normal CTG patterns.[13]

Our study showed a 30.2% NICU admission rate in subjects with abnormal CTG pattern among which 40.26% were with suspicious CTG and 59.74% were with pathological CTG.

Deshpande et al. found that the association between cord blood pH and NICU admissions was statistically significant with p-value of 0.02.[14]

In our study, 55% of babies born with abnormal pH needed NICU admission as against 11.6% of those with normal pH, which was statistically significant. Cord blood pH was a better predictor of neonatal outcome.

Table 4: Neonatal outcome in normal and abnormal umbilical cord pH groups

Parameters	Normal pH group	Abnormal pH group	p value
Low Apgar	8 (4.04)	24 (12.12)	Chi-square = 25.59
Mechanical ventilation/CPAP	1 (0.50)	34 (17.17)	p value = 0.001
Convulsions	0 (0)	10 (5.05)	(significant)
Respiratory distress	17 (8.58)	39 (19.69)	
PPHN	0 (0)	9 (4.54)	
Neonatal sepsis	3 (1.51)	32 (16.16)	
Renal failure	0 (0)	13 (6.56)	
Necrotizing enterocolitis	0 (0)	4 (2.02)	
Mortality	0 (0)	4 (2.02)	

CPAP, continuous positive airway pressure; PPHN, persistent pulmonary hypertension

Table 5: Neonatal outcome in NICU admitted babies born to mothers with suspicious CTG and pathological CTG

Parameter	Suspicious CTG	Pathological CTG	p value
Low Apgar	13 (7.02)	19 (10.27)	Chi-square = 10.59
Mechanical ventilation/CPAP	5 (2.70)	30 (16.21)	p value = 0.101
Convulsions	2 (1.08)	8 (4.32)	(NS)
Respiratory distress	17 (9.18)	39 (21.08)	
Neonatal sepsis	9 (4.86)	26 (14.05)	
Renal failure	1 (0.54)	12 (6.48)	
Mortality	0 (0)	4 (2.16)	

Ramapraba showed a significant correlation between low CTG scores and acidosis and they concluded that the probability of delivering a nonacidotic neonate was high with a good CTG score, and with a poor CTG score, the probability of acidosis for the neonate was significantly increased [positive predictive value (PPV) 95%, negative predictive value (NPV) 70.27%].[2] Our study showed similar results. Babies born with pathological CTG had lower cord pH compared to babies born with suspicious CTG.

Ahmadpour-Kacho et al. in their study on 120 high risk mothers took the cut-off of umbilical arterial cord pH as 7.2 and found the association of short-term outcomes like the need for resuscitation, encephalopathy, convulsions, NICU admission, delay in commencement of oral feeding to be more common in abnormal umbilical cord pH group as against the normal umbilical cord pH group.[15]

The association between neonatal morbidity and mortality and low cord pH was statistically significant in our study, whereas outcome of neonates with suspicious and pathological CTG was not significant.

CONCLUSION

Detecting fetal compromise at the earliest and timely management is of utmost importance. Though cardiotocography is a simple test to analyze the fetal condition, it results in increased intervention for fetal compromise without much impact on the neonatal outcome. There is a clear association between umbilical cord pH and neonatal outcome. It is a good practice to do an umbilical cord blood analysis to detect those neonates who have acidosis and will need further management to prevent future complications. The umbilical artery pH is a good predictor of adverse neonatal outcome and is a useful tool for screening new-borns at risk.

Clinical Significance

Umbilical cord pH less than 7.2 can be used as a prognostic factor for the prediction of neonatal outcome. Our study is one of the very few studies that compare CTG findings based on NICE guidelines with umbilical artery pH and neonatal outcome.

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