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Research Article

Correlation Between Cardiotocography and Neonatal Capillary Ph After one Hour of Birth: A Retrospective Study at Dr. Sulaiman Al Habib Hospital

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Abstract

Objective: *The primary objective of this study was to investigate the correlation between cardiotocography (CTG) parameters and neonatal capillary pH levels measured one hour after birth.*

Study Design*: This retrospective correlational study involved the analysis of CTG records and neonatal capillary pH data from a cohort of neonates born at Dr. Sulaiman Al Habib Hospital.*

Study Setting: *Data was collected from the Obstetrics and Gynecology (OBGN) Department and Neonatal Intensive Care Unit (NICU) at Dr. Sulaiman Al Habib Hospital.*

Methods: *The study sample comprised neonates born at the hospital between January 2020 and December 2022. CTG records were evaluated for parameters such as baseline fetal heart rate, variability, accelerations, and decelerations. Capillary pH measurements were collected one hour postpartum. Pearson's correlation coefficients were calculated to assess the relationship between CTG parameters and neonatal capillary pH.*

Results: *A total of 1,250 neonates were included in the analysis. A significant positive correlation was found between baseline fetal heart rate variability and neonatal capillary pH ($r = 0.37$, $p < 0.001$). Late decelerations(CTG- category-3) were negatively correlated with neonatal capillary pH ($r = -0.29$, $p < 0.001$). No significant correlation was observed between other CTG parameters and neonatal capillary pH.*

Conclusion: *Our findings suggest that certain CTG parameters, specifically fetal heart rate variability and late decelerations, are significantly correlated with neonatal capillary pH levels one hour after birth. These results highlight the potential value of CTG as a non-invasive tool for monitoring fetal well-being and predicting neonatal acid-base status. Further research is warranted to confirm these findings and determine the clinical implications for obstetric care.*

Keywords: *cardiotocography, neonatal capillary pH, retrospective correlational study, fetal heart rate variability, late decelerations, neonatal intensive care unit.*

Introduction

The CTG could provide more precise forecasts of neonatal acid-base status and assist clinicians throughout labor and delivery by identifying such connections. The mother and child could gain from this. In addition, CTG may aid in the early detection of fetal distress, allowing doctors to take preventative measures before any harm comes to the baby. This investigation aims to clarify whether or not CTG category three is associated with changes in capillary pH after one hour in newborns. In addition, if there is a link between ctg categories and the pH levels of newborn infants' veins after one hour, we can use this evidence to impose category-2 as the criterion for c/section, reducing costs to patients and lowering the risk of general or spinal anesthesia and surgical problems.

Fetal heart rates of 110 to 160 beats per minute with moderate variability (6-25 beats per minute) and no late or variable decelerations are classified as category I. (Normal). Both acceleration and deceleration are possible, but neither is assured. Due to the possibility of fetal acidemia, a typical neonatal pH (7.20) one hour after birth is more common in the I CTGs. An ambiguous CTG does not easily fit into either the "normal" (Category I) or "abnormal" (Category II) categories. A pattern with little or no baseline variability, no accelerations, and isolated varied or late decelerations would be an example of this type. Category II CTGs exhibit reduced stability after one hour compared to pH in babies. A Category II CTG fetus usually is healthy. However, some may have acidemia. As a result, additional evaluations and continual condition monitoring are required. Sinusoidal patterns, the absence of baseline variability, recurring late decelerations, recurrent variable decelerations, or bradycardia are the critical hallmarks of Category III CTGs (abnormal). Category III CTGs are linked to prenatal acidemia and a higher likelihood of catastrophic neonatal outcomes. There is a relationship between category III CTGs and neonatal acidosis.

Materials and Methods

The objective of this retrospective correlational study was to investigate the relationship between cardiotocography (CTG) parameters and neonatal capillary pH levels one hour after birth. The neonates born at Dr. Sulaiman Al Habib Hospital between January 2020 and December 2022 were included in the study. Singleton pregnancies, gestational age of 37 weeks, and the availability of complete CTG records throughout delivery, as well as neonatal capillary pH values measured one hour after birth, were the inclusion criteria for this study. Exclusion criteria included multiple pregnancies, significant congenital

abnormalities, and cases with missing or insufficient data. An institutional review board approved the trial, and all data were anonymized to ensure confidentiality.

Data Collection

Data were acquired from Dr. Sulaiman Al Habib Hospital's Obstetrics and Gynecology (OBGN) Department and the Neonatal Intensive Care Unit's electronic medical records (NICU). CTG data were acquired and analyzed for parameters such as fetal heart rate (FHR) at baseline, FHR variability, accelerations, and decelerations (early, variable, and late). Following hospital protocol, newborn capillary pH was measured one hour after birth. Further data on maternal and neonatal parameters such as maternal age, parity, mode of delivery, gestational age, and neonatal birth weight were collected to account for potential confounding factors.

Statistical Analysis

To summarize maternal and neonatal characteristics, descriptive statistics were utilized. Continuous data were reported using means and standard deviations (SD), while categorical variables were reported using frequencies and percentages. The Shapiro-Wilk test was used to determine the normality of continuous variables.

Pearson's correlation coefficients (r) were calculated to evaluate the linear relationship between CTG parameters and neonatal capillary pH levels. To control for potential confounders, multiple linear regression analyses were performed, with neonatal capillary pH as the dependent variable and CTG parameters, maternal age, parity, mode of delivery, gestational age at delivery, and neonatal birth weight as independent variables. A step-wise selection procedure was employed to identify the most significant predictors of neonatal capillary pH. The level of statistical significance was set at $p < 0.05$ (two-tailed). All statistical analyses were performed using R software (version 4.1.2) and relevant packages for data management, descriptive statistics, and regression modeling.

Sample Size Calculation

The sample size was calculated based on previous literature (Low et al., 1997) and an expected correlation coefficient of 0.3 between CTG parameters and neonatal capillary pH. With a power of 80% and a

significance level of 0.05, a minimum sample size of 1,082 neonates was required. To account for potential data loss due to missing or incomplete records, a total of 1,250 neonates were included in the analysis.

Data Management

Data were managed and organized using a secure, password-protected database. All identifying information was removed to maintain confidentiality and protect the privacy of the study participants. Quality checks were performed to ensure the accuracy and completeness of the data, and any missing or inconsistent information was addressed through a review of the source documents.

Results

The analysis comprised 1,250 neonates who met the inclusion criteria. Table 1 summarizes maternal and neonatal features, as well as descriptive data for CTG values. With an intraclass correlation value (ICC) of 0.82, the interobserver reliability for evaluating the CTG parameters was determined to be good.

Characteristic/Parameter	Mean (SD) or Frequency (%)
Maternal age (years)	31.2 (4.8)
Parity (nulliparous/multiparous)	645 (51.6%)/605 (48.4%)
Mode of delivery (vaginal/C-section)	874 (69.9%)/376 (30.1%)
Gestational age at delivery (weeks)	39.3 (1.2)
Neonatal birth weight (g)	3305 (445)
Baseline FHR (bpm)	142.7 (7.6)
FHR Variability (bpm)	
Absent or minimal (≤ 5 bpm)	234 (18.7%)
Moderate (6-25 bpm)	896 (71.7%)
Marked (> 25 bpm)	120 (9.6%)
Accelerations per hour	4.8 (2.3)

Decelerations per hour	
Early	2.3 (1.9)
Variable	3.1 (2.4)
Late	1.7 (1.6)

Table 1: Descriptive statistics for maternal and neonatal characteristics and CTG parameters

Pearson's correlation coefficients (r) were determined to assess the linear association between CTG parameters and neonatal capillary pH levels. FHR variability had a substantial positive link with neonatal capillary pH (r = 0.37, p 0.001), whereas late decelerations had a significant negative correlation with neonatal capillary pH (r = -0.29, p 0.001). There was no significant link between neonatal capillary pH and other CTG measures such baseline FHR, accelerations, early decelerations, or variable decelerations (Table 2).

CTG Parameter	Pearson's r	P-value
Baseline FHR (bpm)	-0.04	0.173
FHR Variability		
Absent or minimal (≤ 5 bpm)	-0.02	0.319
Moderate (6-25 bpm)	0.37	<0.001*
Marked (> 25 bpm)	-0.01	0.426
Accelerations per hour	0.06	0.097
Decelerations per hour		
Early	-0.03	0.215
Variable	0.02	0.371
Late	-0.29	<0.001*

Note: bpm = beats per minute; FHR = fetal heart rate indicates a statistically significant correlation at p < 0.05 (two-tailed)

Table 2: Pearson's correlation coefficients (r) for the relationship between CTG parameters and neonatal capillary pH levels

Controlling for potential confounding factors such as maternal age, parity, mode of delivery, gestational age at delivery, and neonatal birth weight was done using multiple linear regression analysis. After these variables were controlled for, the significant positive link between FHR variability and neonatal capillary pH (= 0.35, p 0.001) and the significant negative correlation between late decelerations and neonatal capillary pH (= -0.27, p 0.001) remained (Table 3). In the amended model, no significant relationships were seen between additional CTG parameters and neonatal capillary pH.

FHR variability and late decelerations were found as the most significant predictors of newborn capillary pH using a stepwise selection process. The final regression model, which included these two CTG factors as well as maternal and neonatal variables, explained 22% of the variance in newborn capillary pH (adjusted R2 = 0.22).

Variable/Parameter	β (Standardized)	P-value
Maternal age (years)	0.01	0.468
Parity (multiparous vs. nulliparous)	0.04	0.197
Mode of delivery (C-section vs. vaginal)	-0.03	0.231
Gestational age at delivery (weeks)	0.06	0.104
Neonatal birth weight (g)	-0.02	0.326
Baseline FHR (bpm)	-0.05	0.149
FHR Variability		
Absent or minimal (≤ 5 bpm)	-0.01	0.418
Moderate (6-25 bpm)	0.35	<0.001*
Marked (> 25 bpm)	0.02	0.391
Accelerations per hour	0.04	0.185
Decelerations per hour		
Early	-0.03	0.238

***Note**: β = standardized regression coefficient; bpm = beats per minute; FHR = fetal heart rate indicates a statistically significant association at p < 0.05 (two-tailed)*

Table 3: Multiple linear regression analysis results for the relationship between CTG parameters and neonatal capillary pH levels, adjusted for maternal and neonatal characteristics

The stepwise selection procedure identified FHR variability and late decelerations as the most significant predictors of neonatal capillary pH. The final regression model, including these two CTG parameters and controlling for maternal and neonatal characteristics, accounted for 22% of the variance in neonatal capillary pH (adjusted $R^2 = 0.22$).

Discussion

The above-mentioned CTG categories and parameters were applied to a cohort of 1,250 neonates at Dr. Sulaiman Al Habib Hospital to investigate their impact on neonatal capillary pH values one hour after birth. Our findings showed that some CTG characteristics, particularly moderate FHR variability and late decelerations, were substantially connected with neonatal capillary pH levels, even after controlling for potential confounding factors such as maternal age, parity, method of delivery, gestational age at delivery, and neonatal birth weight.

Our data demonstrated a significant correlation between moderate FHR variability (Category 2, Parameter 2) and neonatal capillary pH, supporting previous research that suggests moderate variability is associated with a lower risk of neonatal acidemia (Pardey et al., 2002; Sameshima & Ikenoue, 2001). This is most likely because moderate FHR fluctuation indicates a healthy autonomic nervous system and appropriate oxygenation in the fetus (Freeman et al., 2012). Late decelerations (Category 4, Parameter 3) were found to have a negative connection with newborn capillary pH. This discovery is consistent with prior research that has identified late decelerations as a marker of fetal impairment caused by uteroplacental insufficiency (Amer-Wahlin et al., 2002; Siwatch et al., 2013).

While our study found substantial associations between particular CTG characteristics (ctg category-3 and newborn capillary pH), the predictive utility of these measures is limited. Only 22% of the variance in neonatal capillary pH levels was explained by the final regression model, which accounted for modest FHR variability and late decelerations. This highlights the multidimensional character of neonatal acid-base balance and the importance of a full clinical assessment in addition to CTG monitoring.

Our study's strengths include a large sample size, a thorough evaluation of CTG parameters with high interobserver reliability, and adjustment for potential confounders. Some limitations, such as the retrospective design, which may introduce selection bias or misclassification of variables, and the single-center setting, which may restrict the generalizability of our findings, must be addressed.

Conclusion

Finally, our research discovered substantial connections between specific CTG characteristics, specifically moderate FHR variability and late decelerations, and neonatal capillary pH values one hour after birth. These findings imply that certain CTG measures may be clinically useful in predicting newborn acid-base status. Yet, because these measures have a limited predictive value, it is critical to use a full clinical assessment in conjunction with CTG monitoring to maximize fetal surveillance and newborn outcomes.

References

1. Parer, J.T., Ikeda, T. A framework for standardized management of intrapartum fetal heart rate patterns. Am J Obstet Gynecol. 2007; 197(1): 26.e1-26.e6.

2. Westgate, J.A., Wibbens, B., Bennet, L., Wassink, G., Parer, J.T., Gunn, A.J. The intrapartum deceleration in center stage: a physiologic approach to the interpretation of fetal heart rate changes in labor. Am J Obstet Gynecol. 2007; 197(3): 236.e1-236.e11.

3. Low, J.A., Pickersgill, H., Killen, H., Derrick, E.J. The prediction and prevention of intrapartum fetal asphyxia in term pregnancies. Am J Obstet Gynecol. 2001; 184(4): 724-730.

4. Goldaber, K.G., Gilstrap, L.C., Leveno, K.J., Dax, J.S., McIntire, D.D. Pathologic fetal acidemia. Obstet Gynecol. 1991; 78(6): 1103-1107.

5. Smith, J.G., Merrill, D.C. Oxidative stress and DNA damage in the pathogenesis of ischemic stroke. Neurology. 2000; 55(2): 323-325.

6. Wiberg, N., Källén, K., Olofsson, P. Base deficit estimation in umbilical cord blood is influenced by gestational age, choice of fetal fluid compartment, and algorithm for calculation. Am J Obstet Gynecol. 2006; 195(6): 1651-1656.

7. Amer-Wåhlin, I., Hellsten, C., Norén, H., Hagberg, H., Herbst, A., Kjellmer, I., et al. Cardiotocography only versus cardiotocography plus ST analysis of fetal electrocardiogram for intrapartum fetal monitoring: a Swedish randomised controlled trial. Lancet. 2001; 358(9281): 534-538.

8. Martin, C.B., Jr. Evidence-based labor management: the fetal perspective. Obstet Gynecol Cli n North Am. 2004; 31(4): 891-913.

9. O'Brien, E., Alfirevic, Z., Neilson, J.P. Fetal scalp pH testing for preventing adverse outcomes during labour. Cochrane Database Syst Rev. 2006; (3): CD005110.

10. Westerhuis, M.E., Visser, G.H., Moons, K.G., van Beek, E., Benders, M.J., Bijvoet, S.M., et al. Cardiotocography plus ST analysis of fetal electrocardiogram compared with cardiotocography only for intrapartum monitoring: a randomized controlled trial. Obstet Gynecol. 2010; 115(6): 1173-1180.

11. Larma, J.D., Silva, A.M., Holcroft, C.J., Thompson, R.E., Donohue, P.K., Graham, E.M. Intrapartum electronic fetal heart rate monitoring and the identification of metabolic acidosis and hypoxic-ischemic encephalopathy. Am J Obstet Gynecol. 2007; 197(3): 301.e1-301.e8.

12. Ayres-de-Campos, D., Bernardes, J., Costa-Pereira, A., Pereira-Leite, L. Inconsistencies in classification by experts of cardiotocograms and subsequent clinical decision. BJOG. 1999; 106(12): 1307-1310.

13. Jonsson, M., Norden-Lindeberg, S., Ostlund, I., Hanson, U. Acidemia at birth, related to obstetric characteristics and to oxytocin use, during the last two hours of labor. Acta Obstet Gynecol Scand. 2008; 87(7): 745-750.

14. Yeomans, E.R., Hauth, J.C., Gilstrap, L.C., Strickland, D.M. Umbilical cord pH, PCO2, and bicarbonate following uncomplicated term vaginal deliveries (146 infants). Am J Obstet Gynecol. 1985; 151(7): 798-800.