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Correlation between Nonreassuring Patterns in Fetal Cardiotocography and Birth Asphyxia

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Abstract

Objectives: Cardiotocography (CTG) is a tool for assessing the fetus during labor and identifying the risk of asphyxia. Abnormal CTG can lead to stress in the physician and mother and result in their decision in terminating the pregnancy and the complications of an emergency cesarean section. The purpose of this study was the evaluation of the correlation between nonreassuring patterns in fetal CTG and birth asphyxia.

Materials and Methods: In a cross-sectional analytic study, 324 term pregnant women were included. The association between nonreassuring patterns in CTG (fetal tachycardia, fetal bradycardia, absent or minimal baseline variability, and absence of acceleration and periodic or episodic deceleration) and birth asphyxia were assessed.

Results: Birth asphyxia existed in 10 newborns; in all cases mild hypoxic ischemic encephalopathy (HIE) was observed. Within the nonreassuring CTG patterns, baseline fetal heart variability and periodic or episodic deceleration had a significant relationship with birth asphyxia. Most asphyxia cases had occurred in absent and minimal baseline fetal heart rate (FHR) variability ($R = 0.49$, $P < .001$). In periodic or episodic decelerations, most asphyxia cases occurred in recurrent late decelerations with normal baseline variability and variable decelerations with shoulders or overshoots ($R = 0.42$, $P = .014$).

Conclusion: With regard to the findings of the present study we can use nonreassuring cardiotocographic patterns, especially absent and minimal baseline FHR variability and periodic or episodic decelerations in prediction of birth asphyxia. It seems however that most birth asphyxias occur in normal cardiotocographs.

Keywords: Asphyxia, Cardiotocography, Pregnancy

Introduction

Perinatal asphyxia is a disorder resulting from reduced gas exchange in the placenta. This disorder can lead to hypoxia and hypercapnia in fetal blood, and thus, the production of lactic acid in the tissues of the fetus. Hypoxia and acidosis can cause a decrease in myocardial performance and result in hypotension and ischemia in the fetus. Ischemia impairs oxygen delivery to the tissues which further exacerbates organ dysfunction and accumulation of lactic acid and carbon dioxide in the blood of the fetus (1). A series of various maternal, obstetrical, and fetal factors cause hypoxia in the fetus and asphyxia in the newborn. Therefore, the risk factors are associated with decreased blood flow and oxygenation to the tissues (2,3). The exact definition of birth asphyxia is given by the American College of Obstetrics and Gynecology (ACOG) and includes the existence of 3 factors which are:

1. Metabolic or mixed acidemia (pH < 7.0) which is determined by umbilical artery blood samples
2. Apgar score of ≤3 for more than 5 minutes
3. Evidence of neurologic damage such as seizures, coma, hypotonia or dysfunction of one or more systems that include cardiovascular, gastrointestinal, hematological, pulmonary and renal systems (4).

Nonreassuring fetal heart rate (FHR) patterns or category2 of the three tire interpretation system of FHR, based on the National Institute of Child Health and Human Development (NICHD) workshop suggestion on electronic monitoring of FHR include bradycardia, tachycardia, lack of acceleration, lack of variability and periodic or episodic deceleration (recurrent variable deceleration, prolong deceleration, and late deceleration with baseline variability) (5).

Cardiotocography (CTG) is known as a tool to assess the fetus during labor (6). Studies have shown that asphyxia and hypoxic ischemic encephalopathy (HIE) in 79% of cases were associated with an abnormal CTG (7). Researchers, in studying healthy pregnant women during labor with continuous CTG and fetal pulse oximetry concluded that a significant association exists between short-term variability in CTG and fetal blood oxygen saturation in the second stage of labor. Fetal pulse oximetry in the assessment of fetal health can be valuable especially when the results of CTG are abnormal (8). CTG has

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high false-positive results and is a poor predictor of fetal hypoxia and metabolic acidosis. In one study, even with significant abnormality in CTG, the risk of fetal acidosis was only 50% (9). A high percentage of cesarean deliveries are due to fetal distress (based on CTG), and identifying the status of the fetus using pH measurement of fetal scalp blood in cases of abnormal CTG is required and this is currently not possible for our patients. Considering the above-mentioned reports, this study investigated the relationship between nonreassuring patterns in CTG and birth asphyxia in order to understand cases of nonreassuring fetal heart pattern and emergency termination of pregnancy due to concerns about the condition of the fetus and to what extent these changes were related to birth asphyxia.

Materials and Methods

In this cross-sectional analytical study, 324 pregnant women, who were in their 38th week of pregnancy or higher and had the inclusion criteria, were studied. The study environment included 2 specialized training hospitals affiliated with Tabriz University of Medical Sciences, Iran. The total study period was 11 months; from October 2011 to September 2012. Initial data collection, patient evaluation and analysis of the data were performed.

In this study, due to the frequency of arrhythmias in the studied groups, for each specific purpose a sample size was calculated. Finally, considering a maximum error of the first kind of 0.05, power of 80%, the risk of arrhythmia in 15% of cases (reference), and 0.08% difference in the incidence of arrhythmias, 285 samples were estimated. However, in this study, 324 pregnant women, who had the inclusion criteria, were examined. Since this was a descriptive-analytical study, diagnostic value was not considered; thus, there was no need for a control group.

CTG was performed for all the women who were in their 38th week of pregnancy or higher, and had referred to the hospital due to the onset of labor pain, uterine contractions, reduced fetal movements and rupture of membranes. If the initial CTG or the subsequent CTGs had recorded nonreassuring patterns and the pregnancy was terminated within less than 30 minutes of detection, they were included in the study. The exclusion criteria included patients with intrauterine growth restriction (IUGR), multiple pregnancies, preterm pregnancy (gestational age of less than 37 weeks), fetal anomalies and genetic disorders.

Patients were examined carefully and CTG findings and non-reassuring patterns were recorded. After termination of pregnancy, arterial blood sample was taken from the umbilical cord and was sent to the laboratory for pH, PCO_2, PO_2, HCO_3, and base excess (BE) measurements. Apgar in the first, fifth and tenth minutes of the infant were determined and recorded. The information obtained from CTG, first, fifth and tenth minute Apgar score and blood samples from the umbilical cord were recorded in the checklist. According to the results of Apgar score of the first, fifth and tenth minutes after birth and the results of umbilical cord blood samples, symptoms of neonatal encephalopathy and birth asphyxia were evaluated. Then, the nonreassuring fetal patterns association with other variables, such as Apgar score, asphyxia and the severity of neonatal encephalopathy were studied.

Statistical Analysis

The results are shown as mean ± SD, frequency and percentage. SPSS for Windows (version 16; SPSS Inc., Chicago, IL, USA) was used. For quantitative variables *t* test, Fisher exact test and Pearson correlation were used and for qualitative variables chi-square test and Fisher exact test was conducted. In all studied cases, the results with $P < .05$ were considered to be statistically significant.

Results

The minimum and maximum age of the patients was 16 and 45 years, (mean age: 25.56±5.74 years). Among the studied women 32 (9.8%) had a history of abortion. The mean gestational age of the study population was 38.93 ± 1.25 weeks. Of the 324 cases studied, 157 (48.4%) infants were male and 170 (51.6%) were female. Regarding the delivery method, 322 patients (99.4%) used cesarean and the remaining 2 patients (0.6%) used vaginal delivery for childbirth.

Incidences of nonreassuring patterns were as follows: 8 cases (2.4%) were tachycardia and 12 cases (3.7%) were bradycardia (7 cases [2.2%] were rated 100-110, 1 case [0.3%] was rated 80-100, and 4 cases [1.2%] were rated below 80). All cases of fetal bradycardia were associated with normal variability. Baseline variability was normal in 309 patients (95.3%), absent in 2 patients (0.7%) and minimal in 13 patients (4%). Due to the small number of absent cases, for later analysis, the 2 groups were placed into 1 group. In terms of acceleration, 173 cases (53.3%) had acceleration and 151 cases (46.7%) did not have acceleration. Periodic or episodic deceleration frequency is given in the Figure 1.

Apgar Score Description

The first minute mean Apgar score of the study population was 8.69 ± 0.85 (in the range of 2 to 10). The mean fifth minute Apgar score of the study population was 9.80 ± 0.53 (in the range of 6 to 10). The 10th minute Apgar score of the study population was 9.87 ± 0.67 (in the range of 1 to 10). Error bar of mean Apgar score in the first and fifth minutes is given in the Figure 2.

The pH of umbilical arterial blood in 10 infants (3.1%) was less than 7, in 116 infants (35.8%) was between 7-7.2 and in the remaining infants (61.1%) was higher than 7.2. Only in 10 cases (3.1%) asphyxia, based on the mentioned criteria, was observed and in the other 314 cases (96.9%) it was not observed. In all cases, the infants were discharged in good health. There was no significant relationship between asphyxia and fetal tachycardia ($r = -0.02$, $P = .635$). Moreover, there was no significant relationship between bradycardia at baseline and asphyxia ($r = -0.03$, $P = .532$). Although asphyxia was observed in patients

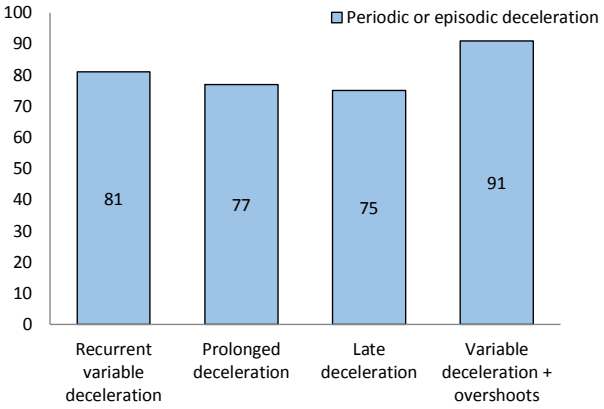

Figure 1. Periodic or Episodic Decelerations Frequency.

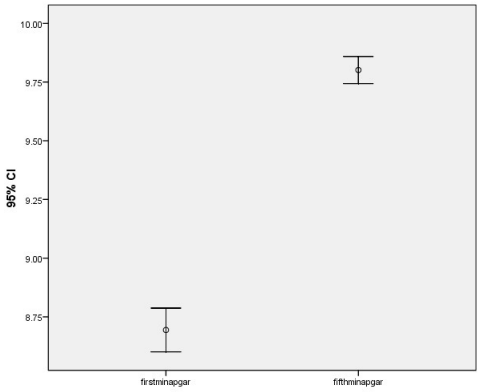

Figure 2. Error Bar for the Mean Apgar Score in the First and Fifth Minutes.

who had acceleration, there was no significant correlation between the two (r = 0.02, *P* = 0.205). There was a relationship between baseline FHR variability and fetal asphyxia, meaning that most cases of asphyxia occurred in cases with minimal or absent baseline FHR variability (r = 0.49, *P* < .001). Between periodic or episodic deceleration and asphyxia there was a significant relationship. This means that the majority of cases of asphyxia in late recurrent decline were associated with normal baseline variability and in variable decline with shoulders or overshoots (r = 0.42, *P* = .014).

Discussion

In this study there was a relationship between the nonreassuring patterns of CTG at baseline FHR variability and periodic or episodic deceleration in the prediction of cases with birth asphyxia. Leszczynska-Gorzelak et al (8) conducted a similar study in Poland and announced that CTG is a non-invasive basic method used to assess the condition of the fetus during pregnancy and childbirth (8). In the current study, it was also concluded that computerized CTG during childbirth results in the reduction of perinatal morbidity and mortality. The researchers of the present study continuously monitored 26 healthy pregnant women during labor using CTG and fetal pulse oximetry. They observed a significant relationship between short-term variability in CTG and fetal blood oxygen saturation in the second stage of labor. Thus, the researchers concluded that fetal pulse oximetry may be of value in assessing fetal health, especially when the results of CTG are abnormal (8). In the present study, there was a relationship between FHR variability and fetal asphyxia, meaning that the highest rate of cases of asphyxia at baseline FHR variability occurred first in normal subjects and then in cases with absent and minimal variability (R = 0.498, *P* < .001). These results were in agreement with that of the study by Leszczynska-Gorzelak et al (8).

In another systematic review conducted by Visser in 2005, it was noted that the abnormalities of FHR were associated with the occurrence of fetal hypoxemia. It was concluded that there was a direct relationship between changes in FHR and umbilical vein PO_2 (10). Unlike the study by Visser, in the present study, there was no significant correlation between asphyxia and acceleration (R=0.026, *P* = .205). Nevertheless, there was a significant relationship between asphyxia and periodic or episodic deceleration, meaning that the majority of asphyxia cases in late recurrent decline were associated with normal baseline variability and in variable decline with shoulders or overshoots (R = 0.422, *P* = .014).

In a similar clinical trial conducted on 6826 cases by Olofsson in Sweden in 2003, CTG alone was compared with CTG combined with ST segment analysis and fetal electrocardiography (ECG). The researchers concluded that CTG combined with ST segment analysis increased gynecologists' ability of detecting fetal hypoxia and performing more effective interventions (11). Unlike the study by Olofsson, in the present study, due to limitations, reviewing neonatal ECG and assessment of ST segment along with CTG in the prediction of cases associated with fetal asphyxia was not feasible. In this study, of the 327 infants studied, only 10 (3.1%) had asphyxia, all of whom had mild HIE.

The study by Murphy et al (12) in the UK conducted for a 17-month period on 38 term infants who had severe asphyxia showed that abnormal or nonreassuring patterns in CTG during labor were observed in 33 newborns with asphyxia. In addition, 23 newborns with asphyxia also had metabolic acidosis.

In general, the problem currently associated with nonreassuring patterns in CTG and fetal asphyxia is the identification of criteria that can provide information on the risk of future problems of infants. On the other hand, neonatal asphyxia is associated with numerous short-term and long-term complications for the infant, and can have an immense emotional and financial burden on the parents for many years. Furthermore, the doctor can be accused of failing to detect and identify these cases on time and thus lack of medical management. Therefore, it is necessary to identify patterns in CTG that have direct relationship with fetal asphyxia and by the detection of which the possibility of asphyxia can be proposed with high sensitivity and specificity. As a result of this and by conducting appro-

priate measurements the complications of asphyxia can be prevented.

The limitation of the present study was the interpretation of the CTGs by only 2 individuals, 1 assistant and 1 of the professors participating in the study. Given that the existence of disagreements in the interpretation of the CTGs has been proven, it would have been better if it had been interpreted by several professionals. It also seems that more multicenter trials with greater sample sizes are essential to summarize and present a series of comprehensive and acceptable criteria for obstetricians to predict fetal asphyxia cases.

Conclusion

Considering the results of the study and the importance of birth asphyxia, the nonreassuring patterns of CTG, especially FHR variability and periodic or episodic deceleration, can be used in the prediction of cases associated with birth asphyxia.

Ethical issues

The study was approved by Vice Chancellor for Research of Tabriz University of Medical Sciences.

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Conflict of Interests

The authors have no conflicts of interest to disclose.

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