Interrelations Among Abnormal Cardiotocograms in Labor, Arterial Cord Blood pH, Base Deficit, and Apgar Scores in Pregnancies

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ÖZET

Gebelerde Anormal Kardiotokogram, Arterial Kord Kanı pH'sı, Baz Açığı ve Düşük Apgar Skorları Arasındaki İlişki

Amaç: *Gebelerde fetal asidozu belirlemek için fetal kalp hızının klinik doğruluğunu değerlendirmek.*

Gereç ve yöntem: *Doğum eylemindeki 38-40 gebelik haftaları arasındaki 55 gebe kardio-tokogram ile monitorize edildi ve doğumda umbilikal kordon gaz analizleri çalışıldı. Umbilikal kordon kan gazları sonuçlarını ve neonatal bebeklerin durumlarını bilmeyen bir araştırmacı, fetal kalp atım traselerini değerlendirdi. Variabilite kaybı (amplitüd < 5 atım), variabil ya da geç deselerasyon anormal kalp atım paterni olarak değerlendirildi. Umbilikal arter PH < 7.1, 1. ve 5. dakika Apgar skorları < 7 ve umbilikal arter baz açığı > -14 değerleri fetal asidoz olarak değerlendirildi. Fetal kalp atım paternleri, umbilikal kan gazı, baz açığı ve Apgar skorları fetal asidozun prediksiyonu için çalışıldı. İstatistiksel değerlendirmede Ki-kare (Fisher's exact) test kullanıldı. P < 0.05 değeri istatistiksel olarak anlamlı kabul edildi.*

Bulgular: *Anormal fetal kalp traselerinin düşük Apgar skorun düşüklüğünü belirlemedeki sensitivite, spesifisite, pozitif ve negatif prediktif değerleri 1. dakika için sırasıyla, % 100, % 90.2, % 44.4, % 100 ve 5. dakika için % 100, % 88.9, % 14.3 ve % 100 bulundu. Anormal fetal kalp hızı paterninin umbilikal arter pH'sının < 7.1 olmasını belirlemedeki sensitivite, spesifisite, pozitif ve negatif prediktif değerleri sırasıyla % 88.8, % 97.8, % 88.9 ve % 97.8 bulundu. Anormal fetal kalp hızı paternlerinin umbilikal arter baz açığını belirlemedeki sensitivite, spesifisite, pozitif ve negatif prediktif değerleri sırasıyla, % 75.0, % 93.6, % 66.7 ve % 95.6 bulundu.*

Sonuç: *Fetal kalp hızı monutörizasyonu fetal asideminin saptanmasında faydalı olsa bile, anormal trase varlığında operatif doğum oranlarında artışa neden olmaktadır. Bu nedenle, obstetrisyen anormal trase varlığında yüksek yalancı pozitiflik nedeniyle gereksiz sezaryen doğumlardan kaçınmalıdır.*

Anahtar kelimeler: *Anormal fetal kalp hızı paternleri, fetal asidoz, umbilikal kan gazı, umbilikal baz açığı*

SUMMARY

Objective: *Our purpose was to evaluate the clinical validity of electronic heart rate monitoring in pregnancies and to predict fetal acidosis.*

Materials and Methods: *Fifty-five women between 38 and 40 weeks' gestational age who had electronic fetal monitoring were recruited prospectively and umbilical artery cord gas analysis was performed at delivery. One investigator, blinded to the cord blood gases outcome and using the standard guidelines for fetal heart rate monitoring reviewed all tracings with decreased variability (amplitude < 5 beats). Variable or late decelerations were considered as abnormal fetal heart rate patterns. The occurrences of an umbilical arterial pH of < 7.1, 1- and 5-minute Apgar scores of < 7 and an umbilical artery base deficit of > –14 mmol/L were interpreted as fetal acidosis.*

Results: *The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of abnormal tracings for predicting low Apgar scores were 100 %, 90.2 %, 44.4 %, and 100 % for 1-minute, and 100 %, 88.9 %, 14.3 %, and 100 %, for 5-minute, respectively. The sensitivity, specificity, PPV and NPV of abnormal tracings for predicting umbilical arterial pH of 7.1 were 88.8 %, 97.8 %, 88.9 %, and 97.8 %, respectively. The sensitivity, specificity, PPV and NPV of abnormal tracings for predicting base deficit were 75.0 %, 93.6 %, 66.7 %, and 95.6 %, respectively.*

Conclusion: *Intrapartum fetal heart rate monitoring is useful to detect fetal acidemia, nevertheless, the operative delivery rate is higher among patients with abnormal fetal heart rate patterns. The obstetrician should therefore, be aware of the high false positivity rate of abnormal tracings in order to avoid unnecessary caesarean delivery.*

Key words: *Abnormal fetal heart rate patterns, fetal acidosis, umbilical blood gas, umbilical base deficit*

INTRODUCTION

Electronic fetal monitoring (EFM) is a routine procedure in Obstetrics. Indeed, in many hospital labor and delivery units, it has become a standard of care. However, continuous EFM for all women, regardless of risk status, conflicts with guidelines presented by many well-known professional groups as well as many intuitional policies. It should be noted that, at least 60 % of fetal heart tracings in labor are abnormal or variant, that is, the tracing is not the normal reassuring non-acidotic pattern.

In 1999, more than 3 million (84 %) women in the United States who gave birth were electronically monitored (1). Since its introduction, continuous EFM has contributed to the rise in the caesarean section rate (2), has failed to reduce the incidence of cerebral palsy, and is responsible for 70 % of all claims concerning intrapartum in relation to brain damage (3). Thus, the value of EFM is being questioned as it is associated with a high false positive rate and an increased rate of caesarean section for fetal distress (4). The aim of this study was to determine the predictive value of EFM for intrapartum fetal asphyxia.

MATERIALS and METHODS

We did this prospective study at our university clinic between January 2003 and December 2003. The study population consisted of 55 low-risk pregnant women with singleton fetuses of gestational age between 38 and 40 weeks, delivering in our birthing unit. Gestational age was determined by a combination of reliable last menstrual period and ultrasonographic measurements, which was obtained during first or second trimester.

The exclusion criteria were patients with abnormal FHR (fetal heart rate) patterns on admission, vaginal bleeding, placenta previa, premature ruptured membranes, fetal anomalies, and meconium staining of the amniotic fluid. Women were excluded if they were unsure about the date of onset of their last menstrual period or if their last menstrual period was not normal. Eligible women who were willing and able to participate were included in the study after they had given informed concept. This study was also approved by our institutional ethics committee.

Information regarding maternal age, gravidity, parity, and gestational ages were obtained on admission. Transabdominal ultrasonography was performed with a 3.5-MHz transducer (LOGIQ 400 CL PRO Series, 6.5 MHz transducer, US). Continuous fetal monitoring was obtained in all patients using an external monitor (Sonicaid Team Standart, Medical Systems Division, Oxford, England) during labor and umbilical artery cord blood gas analysis was performed at delivery.

Immediately after delivery, the umbilical cord was double clamped and blood samples collected from the umbilical artery using preheparinized 2 mL syringes. The blood was analyzed within 15 minutes using a gas analyzer (Roche, Omni C, 2006, Mannheim, Germany). One investigator, blinded to the results of the umbilical cord blood gas tests and neonatal outcome, reviewed all tracings using the National Institute of Child Health and Human Development guidelines for fetal heart rate monitoring (5).

If a FHR pattern was abnormal, then the patient was moved to the lateral position, vaginal examination was done in the variable deceleration, and oxytocin serve was discontinued. In addition to this, oxygen was administrated to the patient with ringer lactate infusion as 500 cc bolus. If, in spite of these preventive measures, abnormal fetal heart rate pattern was not improved, then caesarean section or operative vaginal delivery was done. Occurrences of umbilical arterial pH of < 7.1, 1-minute and 5-minute Apgar scores of < 7, or base deficits of $>$ -14 mmol/L were considered fetal acidosis (6,7). Interrelationships among abnormal cardiotocograms in labor, arterial cord blood pH and base deficit, and Apgar scores were assessed and predictive values for fetal acidosis were investigated. The statistics included analysis of Chi-square test (Fisher's exact) and Student t test. Significance was set at $P < 0.05$.

RESULTS

A total of 55 patients were enrolled in the study. The mean age (± standard deviation [SD]) of the study subjects was 24.7 ± 4.6 (19-36) years, the mean parity was 0.9 ± 1.2 (0-6), and the mean gestational age was 39.1 ± 2.4

weeks of gestation. A normal FHR pattern was observed in 80 % (n=44) of the pregnancies and an abnormal FHR pattern was observed in 20 % (n = 11) of the pregnancies through all stages of labor. Between these two groups the difference was not ranked as significant according to umbilical artery pH and base deficit (Student t test, P > 0.05) **(Table 1)**.

Table 1. Umbilical artery pH and base deficit at labor

	Normal FHR pattern (n=44)	Abnormal FHR pattern (n =11)	p
PH	7.24 ± 0.05 (7.40-7.00)	**7.20 ± 0.20 (6.82-7.40)**	NS*
Base deficit	-4.82 ± -2.71 (0.5, -15.6)	-5.13 ± -6.24 (-1.54, -31.5)	NS*

Values are presented as mean SD; *NS, not significant

An abnormal FHR pattern was found in 4 (7.3 %) infants with a 1-minute Apgar score of < 7. Five of 51 infants with 1-minute Apgar scores of 7 had abnormal FHR and 46 infants had normal FHR during labor (P < 0.001). An abnormal FHR pattern was found in 1 infant with a 5-minute Apgar score of < 7. A normal FHR pattern was found in 48 of 54 infants with 5-minute Apgar scores of 7, whereas abnormal FHR pattern was found in 6 infants with 5-minute Apgar scores of 7 (Fisher's exact Chi-square test, P < 0.05).

Sensitivity, specificity, PPV, and NPV of fetal heart rate patterns for the low Apgar scores were 100 %, 90.2 %, 44.4 %, and 100 % for the 1-minute and 100 %, 88.9 %, 14.3 %, and 100 % for the 5-minute Apgar scores, respectively. There was a statistically significant relationship between an abnormal FHR pattern and an umbilical artery pH of < 7.1. During labor, 46 patients had normal FHR patterns, but 1 of the 46 patients had an umbilical artery pH less than 7.1. Nine patients had abnormal FHRs and an umbilical artery pH of < 7.1 was found in 1 of these 9 (Fisher's exact Chi-square test, P < 0.05). Sensitivity, specificity, PPV, and NPV of abnormal fetal heart rate patterns for the umbilical artery pH of < 7.1 were 88.9 %, 97.8 %, 88.9 %, and 97.8 %, respectively. The fetal heart pattern was normal in 46 patients and the base deficit was > -14 mmol/L in 2 of 46. Nine patients had abnormal FHRs and the base deficit was > -14 mmol/L in 6 of these 9. Sensitivity, specificity, PPV, and NPV of abnormal fetal heart rate patterns for the umbilical artery base deficit were 75.0 %, 93.6 %, 66.7 %, and 95.6 %, respectively **(Table 2)**.

Table 2. The relationship between abnormal FHR patterns and fetal acidosis

Abnormal FHR Pattern	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Umbilical artery pH < 7.1	88.9	97.8	88.9	97.8	96.4
Umbilical artery base deficit > -14	75.0	93.6	66.7	95.6	90.9
Apgar score at 1 min < 7	100	90.2	44.4	100	90.9
Apgar score at 5 min < 7	100	88.9	14.3	100	89.0

PPV, positive predictive value; NPV, negative predictive value

Abnormal FHR pattern was observed in 7 of 11 (63.6 %) patients who underwent caesarean delivery and 4 (36.4 %) with spontaneous vaginal delivery. **Table 3** shows umbilical arterial pH and Apgar scores at 1- and 5-minutes, and base deficit between these two delivery manners.

Table 3. Comparison between umbilical artery pH and base deficit and Apgar scores in abnormal FHR patterns according to caesarean and vaginal delivery

	Caesarean delivery (n=7)	Vaginal delivery (n=4)	p
1-min Apgar	7.08 ± 1.96 (3-8)	7.1 ± 0.28 (3-8)	NS*
5-min Apgar	9.12 ± 1.13 (7-10)	9.30 ± 0.16 (7-10)	NS*
Umbilical arterial pH	7.09 ± 0.16 (6.84-7.22)	7.24 ± 0.14 (6.98-7.30)	S*
Base deficit	-5.34 ± -7.44 (-23, -6)	-5.76 ± -6.92 (-18, -4)	NS*

*NS, not significant; *S, significant

DISCUSSION

The prediction and diagnosis of intrapartum fetal asphyxia are a challenge for the clinician. Fetal asphyxia of a particular degree and duration causes fetal and newborn morbidity and mortality (8). Recently, the incidence of caesarean deliveries has increased (9). Reasons attributed to the increase include the false positive results associated with intrapartum fetal monitoring (10), increasing use of regional anaesthesia (11), and the medicolegal environment (12). Unnecessary intervention with EFM implies false-positive interpretation of the FHR record.

Although EFM is used in more than 80 % of births in the United States today, there is controversy regarding its efficacy (13). Several investigators have tried to reduce the false-positive rate of intrapartum FHR monitoring by using fetal scalp pH or even fetal oxygen saturation monitoring (14,15). Both of these are invasive methods. Fetal heart rate monitoring alone did not predict

the need for caesarean delivery. Real-time ultrasound is readily available in most labor and delivery services and therefore, the biophysical profile (BPP), a non-invasive test, could be a useful adjunct to intrapartum FHR monitoring. One problem with the BPP is, that there is often, not enough time to perform it. The ability to recognize the normal and hence assuredly non-acidotic pattern is relatively simple. Most of the tracings are actually not associated with fetal acidosis. The goal of fetal heart tracing interpretation is to identify those tracings associated with acidemia and to intervene soon enough to minimize metabolic acidemia in the neonate. The secondary goal is to avoid unnecessary caesarean delivery. In another words, the clinician wants to minimize both false negative and false positive interpretations.

Steer et al (16), in a prospective study carried out on 1219 births, found the sensitivity of an abnormal cardiotacogram at any time for acidosis was 80 %. However, the predictive value was low, and 32 % of fetuses had an abnormal cardiotocogram but no acidosis. If only cardiotocogram abnormality in the first stage of labor was considered, sensitivity was still 47 % for acidosis and 67 % for severe acidosis, and the false-positive rate was reduced to only 14 %.

Şanlıalp et al (17), in a prospective study that was conducted on 89 patients with normal and 78 patients with pathologic FHR patterns, found a significant increase in the incidence of caesarean delivery in patients with abnormal FHR patterns ($P < 0.0001$). They found fetal acidosis (pH < 7.20) in only 7 of 20 patients who were delivered with caesarean section.

Çorakcı et al (18), in a prospective study which was conducted with 152 patients, found abnormal FHR patterns in 28 patients (18.5 %). In their study, the sensitivity of abnormal fetal heart rate patterns to high umbilical artery base deficit was 80 %, for low 1-minute Apgar scores was % 100, and for 5-minute Apgar scores was 100 %. However, sensitivity of abnormal fetal heart rate patterns for low umbilical artery pH (< 7.1) was found to be lower, at 60 %. Similar to Çorakcı's study, in our study sensitivity of abnormal fetal heart rate patterns for low umbilical artery pH and for low 1- and 5-minute Apgar scores were found to be as high as 88.9 %, 100%, and 100 %, respectively. Sensitivity of abnormal fetal heart rate patterns for high umbilical artery base deficit was found to be 75.0 %. A major observation of our study was a significant increase in the incidence of cesarean delivery (63.64 %) in patients with abnormal fetal heart rate patterns. However, the increased rate of fetal acidosis in patients with abnormal fetal heart rate patterns shows that EFM has clinical value in intrapartum fetal assessment ($P < 0.05$).

In conclusion, the aim of intrapartum fetal surveillance is the prediction and early diagnosis of asphyxial exposure to prevent morbidity and mortality. Nevertheless, there is no scientific evidence that has identified the most effective method, including frequency or duration of fetal surveillance that ensures optimum results. Continuous EFM has been the most prevalent component of intrapartum fetal assessment. Predictive FHR patterns require supplementary tests such as fetal blood gas and acid-base assessment to confirm the diagnosis of fetal asphyxia, to identify false-positive results and to avoid unnecessary intervention.

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