OBSTETRICS

Success Rate of Intrauterine Fetal Resuscitation in NICHD Category II Abnormal Fetal Heart Rate Pattern

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ABSTRACT

Objectives: To evaluate success rate of intrauterine fetal resuscitation in women with abnormal fetal heart rate (FHR) in National Institute of Child Health and Human Development (NICHD) category II and associated factors.

Materials and Methods: A retrospective cohort study was conducted among 296 women with abnormal FHR in NICHD category II during labor and delivery at Siriraj Hospital. Intrauterine fetal resuscitations were provided according to institutional guideline. Success rate was defined as a return of FHR pattern to NICHD category I within 30 minutes. Related data were extracted from medical record, including baseline and obstetric characteristics, characteristics of abnormal FHR and intrauterine resuscitation, and pregnancy outcomes.

Results: Most of abnormal FHR pattern occurred during active phase of labor (60.5%). Common patterns of NICHD category II were prolonged deceleration (34.8%) and recurrent variable deceleration (32.4%). Success rate of intrauterine resuscitation was 52.4%. Success rate significantly increased when abnormal FHR occurred in latent phase (p < 0.001), accompanied with early deceleration (p < 0.001) or minimal FHR variability (p = 0.031). Logistic regression analysis showed that factors independently associated with failure of intrauterine resuscitation were abnormal FHR during active phase (adjusted odds ratio (OR) 2.8, 95% confidence interval (CI) 1.3-6.4, p = 0.01) or deceleration phase (adjusted OR 13.5, 95%CI 5.1-35.7, p < 0.001), abnormal FHR with late deceleration (adjusted OR 3.4, 95%CI 1.2-9.5, p = 0.023) or variable deceleration (adjusted OR 6.3, 95%CI 2.3-16.9, p < 0.001).

Conclusion: Success rate of intrauterine fetal resuscitation in NICHD category II FHR patterns was 52.4%. Factors significantly associated with success rate were timing of abnormal FHR and characteristics of deceleration.

Keywords: intrauterine fetal resuscitation, NICHD, success rate.

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อัตราความสำเร็จในการช่วยชีวิตทารกในครรภ์เบื้องต้นเมื่อทารกมีลักษณะการเต้นของหัวใจผิดปกติประเภท NICHD category II

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บทคัดย่อ

วัตถุประสงค์: เพื่อประเมินอัตราความสำเร็จของการช่วยชีวิตทารกในครรภ์เบื้องต้นเมื่อทารกมีลักษณะการเต้นของหัวใจผิดปกติประเภท NICHD category II และปัจจัยต่างๆ ที่เกี่ยวข้อง

วัสดุและวิธีการ: ทำการศึกษาในหญิงตั้งครรภ์ทั้งหมด 296 คน ที่มีลักษณะการเต้นของหัวใจทารกผิดปกติประเภท NICHD category II ระหว่างการคลอดที่ในโรงพยาบาลศิริราช หญิงตั้งครรภ์จะได้รับการช่วยชีวิตทารกในครรภ์เบื้องต้นตามแนวทางการรักษาของคณะแพทยศาสตร์ศิริราชพยาบาล โดยอัตราสำเร็จของการช่วยชีวิตในครรภ์เบื้องต้น หมายถึงการที่ลักษณะการเต้นของหัวใจทารกกลับสู่ประเภท NICHD category I ภายในเวลา 30 นาที หลังได้รับการช่วยชีวิตทารกในครรภ์เบื้องต้น ข้อมูลต่างๆ ที่เกี่ยวข้อง เช่น ข้อมูลพื้นฐานเกี่ยวกับการตั้งครรภ์ ลักษณะของการเต้นของหัวใจทารกที่ผิดปกติ การช่วยชีวิตทารกในครรภ์เบื้องต้นที่ได้รับ และผลลัพธ์ของการตั้งครรภ์ เป็นต้น จะถูกเก็บรวบรวมจากเวชระเบียน

ผลการศึกษา: การเต้นของหัวใจทารกที่เต้นผิดปกติพบบ่อยที่สุดในระยะ active phase (ร้อยละ 60.5) ลักษณะของการเต้นของหัวใจทารกที่ผิดปกติที่บ่อย ได้แก่ prolonged deceleration (ร้อยละ 34.8) และ recurrent variable deceleration (ร้อยละ 32.4) อัตราความสำเร็จของการช่วยชีวิตทารกในครรภ์เบื้องต้นเท่ากับร้อยละ 52.4 พบว่าอัตราความสำเร็จจะสูงในกรณีที่อยู่ใน latent phase ($p < 0.001$) ในกลุ่มที่มีการเต้นของหัวใจทารกมีลักษณะ early deceleration ($p < 0.001$) และ minimal variability ($p = 0.031$) การวิเคราะห์แบบโลจิสติคพบว่า ปัจจัยอิสระที่มีความเกี่ยวข้องกับความล้มเหลวในการช่วยชีวิตทารกในครรภ์เบื้องต้น คือ การพบการเต้นของหัวใจทารกในครรภ์ที่ผิดปกติในระยะ active phase (adjusted OR 2.8, 95%CI 1.3-6.4, $p = 0.01$) ระยะ deceleration phase (adjusted OR 13.5, 95%CI 5.1-35.7, $p < 0.001$) และลักษณะการเต้นของหัวใจทารกแบบ late deceleration (adjusted OR 3.4, 95%CI 1.2-9.5, $p = 0.023$) และ variable deceleration (adjusted OR 6.3, 95%CI 2.3-16.9, $p < 0.001$)

สรุป: อัตราความสำเร็จของการช่วยชีวิตทารกในครรภ์เบื้องต้นเมื่อทารกมีลักษณะการเต้นของหัวใจผิดปกติประเภท NICHD category II คือ ร้อยละ 52.4 ปัจจัยที่เกี่ยวข้องกับอัตราสำเร็จคือ ช่วงระยะของการคลอดที่พบความผิดปกติ และลักษณะของอัตราการเต้นของหัวใจทารกที่ผิดปกติ

คำสำคัญ: การช่วยชีวิตทารกในครรภ์เบื้องต้น, NICHD, อัตราความสำเร็จ

Introduction

A variety of systems for interpretation of fetal heart rate (FHR) pattern from electronic fetal monitoring (EFM) have been developed worldwide. In 2008, the National Institute of Child Health and Human Development (NICHD) categorizes intrapartum abnormal fetal heart rate (FHR) patterns into 3 categories[1]. The categorization has been supported by various organizations and authorities and widely adopted into current clinical care and practice. While FHR pattern in NICHD category I is considered normal, FHR pattern in NICHD category II and category III are abnormal FHR patterns that need appropriate management. Abnormal FHR pattern in NICHD category II and III have been reported to increase the risk of neonatal hypoxia, low Apgar scores, neonatal resuscitation and intrauterine fetal death[1, 2].

While FHR pattern in category III is considered pathologically abnormal that needs prompt evaluation and intervention, category II FHR patterns are indeterminate. Although Category II FHR patterns are not always predictive of abnormal fetal acid–base status, they require evaluation and continued surveillance and reevaluation[1-3].

Management algorithm of intrapartum FHR tracings based on NICHD system has been proposed but actual management is individualized according to clinical status and conditions of the pregnant women, characteristics of abnormal FHR pattern, and conditions after intrauterine fetal resuscitation (IUFR) measures[2, 3]. Intrauterine fetal resuscitation consists of various interventions that aim to improve fetal well-being and resolve the abnormal FHR pattern. Proposed interventions for IUFR may include, but are not limited to, provision of maternal oxygen, change in maternal position, discontinuation of labor stimulation, treatment of maternal hypotension, and amnioinfusion[1-6]. Although there is no consensus or definite evidence on the most appropriate or effective interventions, these IUFR measures are generally recommended for fetal safety[2, 3, 5, 7].

From a previous study of 48,444 women in 10 hospitals in the USA, the incidence of category II FHR pattern has been reported to be 22.1%[8]. A recent study from Siriraj Hospital reported the incidence of 30.7%[9]. And despite various IUFR measures, adverse neonatal outcomes have still been related to category II and III FHR patterns, including birth asphyxia and Neonatal Intensive Care Unit (NICU) admission[8, 9].

In Siriraj Hospital, when NICHD category II FHR pattern was detected, various IUFR measures are provided according to institutional guideline, including intravenous fluid administration, oxygen supplementation, maternal lateral recumbent position, and discontinuation of uterotonic agent. However, success rate of such IUFR measures has not been evaluated. Therefore, the main objectives of this study were to evaluate success rate of intrauterine fetal resuscitation in women with abnormal FHR in NICHD category II during labor and to determine factors associated with success or failure of IUFR measures. In addition, another objective was to compare pregnancy outcomes between those with successful and failed IUFR.

Materials and Methods

After approval from Siriraj Institutional Review Board (SIRB), a cross-sectional study was conducted at Department of Obstetrics and Gynecology, Faculty of Medicine, Siriraj Hospital. During August 2017 to February 2018, a total of 296 singleton pregnant women whose intrapartum FHR monitoring showed abnormal FHR pattern in NICHD category II were included. Exclusion criteria were multiple gestation, pre-labor cesarean delivery, fetal anomaly, fetal arrhythmia, and fetal death. A sample size of 280 was required based on the estimated success rate of IUFR of 80% with 5% acceptable error and 10% loss.

According to institutional guideline, all pregnant women received intrapartum FHR monitoring during labor. When abnormal FHR pattern in NICHD category II or III were detected, IUFR was performed immediately as soon as abnormal FHR was detected. The technic included changing maternal position to lateral recumbent position, maternal oxygen supplementation, intravenous fluid administration, and reduction or discontinuation of uterine stimulation as appropriate.

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All the procedures were performed simultaneously. When FHR abnormalities persisted or worsened, management was given according to the guideline, including further observation, operative vaginal delivery, or cesarean delivery, as appropriate for each woman according to stage of labor and maternal and fetal status[1, 2].

Medical records were reviewed and related data were extracted, including baseline characteristics, obstetric data, antenatal and intrapartum characteristics. Abnormalities of FHR patterns were reviewed and classified according to NICHD system[1, 2]. Data on characteristics of abnormal FHR, IUFR techniques, mode of delivery, and neonatal outcomes were collected. The success rate of IUFR was evaluated. In this study, success of IUFR was defined as the return of abnormal FHR pattern to NICHD category I within 30 minutes.

Descriptive statistics including mean, standard deviation (SD), number, and percentage were used to describe various characteristics as appropriate. Student's t test, chi square test, and Fisher exact test were used to compare various characteristics between those with successful and failed IUFR. Multivariate logistic regression analysis was performed to determine independent factors associated with success or failure of IUFR, adjusted for potential confounders. A p value of < 0.05 was considered statistically significant.

Results

A total of 296 pregnant women were included. Table 1 shows baseline characteristics of the women. Mean age was 27.8 years, mean gestational age was 38.4 weeks, and mean body mass index (BMI) was 21.9 kg/m². Majority of the women were nulliparous (60.8%). There were 47 women (15.9%) with obstetric complications, of which, 25 had gestational diabetes, 11 had gestational hypertension, and 6 had preeclampsia. Majority of women had spontaneous onset of labor (93.9%) and 34.5% had spontaneous rupture of membranes. Most did not have meconium-stained amniotic fluid (84.1%) and only 5.7% had thick meconium-stained amniotic fluid. All the women received oxytocin for either labor augmentation or induction and no women received misoprostol.

Table 1. Baseline characteristics of the pregnant women (N=296).

Characteristics	Mean ± SD
Mean age ± SD (years)	27.8 ± 6.4
Mean gestational age ± SD (weeks)	38.4 ± 1.4
Mean BMI ± SD (kg/m2)	21.9 ± 4.2
	N (%)
BMI category	
Underweight	55 (18.6%)
Normal	190 (64.2%)
Overweight/ obese	51 (17.2%)
Nulliparous	180 (60.8%)
Pregnancy with complications	47 (15.9%)
Spontaneous onset of labor	278 (93.9%)
Spontaneous rupture of membranes	102 (34.5%)
Meconium stained AF	
No	249 (84.1%)
Light	30 (10.1%)
Thick	17 (5.7%)

BMI: body mass index, AF: amniotic fluid

Characteristics of FHR abnormalities are shown in Table 2. Most abnormal FHR occurred during active phase of labor (60.5%). Only 15 women (5.1%) had abnormal uterine contraction. Majority of cases (62.8%) had moderate FHR variability, 36.8% had minimal FHR variability.

Pattern of deceleration was variable deceleration in 56.8%, late deceleration in 27.7%, and early deceleration in 15.5% of cases. Common characteristics of NICHD category II were prolonged deceleration (34.8%) and recurrent variable deceleration (32.4%).

Table 2. Characteristics of FHR abnormalities (N=296).

Characteristics	N (%)
Time of abnormal FHR	
Latent phase	51 (17.2%)
Active phase	179 (60.5%)
Deceleration phase	66 (22.3%)
Uterine contraction	
Normal	281 (94.9%)
Abnormal	15 (5.1%)
FHR Variability	
Minimal	109 (36.8%)
Moderate	186 (62.8%)
Marked	1 (0.4%)
Deceleration	
Early	46 (15.5%)
Late	82 (27.7%)
Variable	168 (56.8%)
Characteristic of NICHD category II	
Prolonged deceleration	103 (34.8%)
Recurrent variable deceleration	96 (32.4%)
Minimal variability	57 (19.3%)
Others	40 (13.5%)

FHR: Fetal Heart Rate, NICHD: National Institute of Child Health and Human Development

Outcomes of IUFR are shown in Table 3. None of the women had FHR recovered before the intervention. Improvement of FHR pattern to NICHD category I was found in 52.4% of cases. FHR pattern remained in category II in 45.3% and worsened to category III in 2.4% of cases. Cesarean section was performed in 38.2% of the women and most common indication was FHR abnormality (71.7%). Of 19 women with instrumental deliveries, 13 were due to abnormal FHR pattern and the other 6 were due to prolonged second stage of labor. Apgar score < at 1 and 5 minutes were 9.8% and 1.4%, respectively and NICU admission was required in 2.7% of the newborns. Of 8 newborns who required NICU admission, 4 were due to birth asphyxia, others were due to respiratory.

Pregnancy outcomes were compared between those with successful and failed IUFR and the results are shown in Table 4. Women with failed IUFR were significantly more likely to have cesarean delivery (59.6% vs. 18.7%, p < 0.001) and have abnormal FHR as an indication (94% vs. 6.9%, p < 0.001). In addition, failed IUFR was significantly associated with

lower Apgar scores at both 1 and 5 minutes and   NICU admission

Table 3. Outcomes of intrauterine fetal resuscitation and pregnancy outcomes (N=296).

Pregnancy outcomes	N (%)
FHR pattern after resuscitation	
Category I	155 (52.4%)
Category II	134 (45.3%)
Category III	7 (2.4%)
Pregnancy outcomes	
Mean birth weight ± SD (g)	3058 ± 412.0
Mode of delivery	
Vaginal delivery	164 (55.4%)
Instrumental vaginal delivery	19 (6.4%)
Cesarean section	113 (38.2%)
Indication for cesarean section (n = 113)	
CPD	32 (28.3%)
FHR abnormality	81 (71.7%)
Apgar score < 7	
At 1 min after birth	29 (9.8%)
At 5 min after birth	4 (1.4%)
NICU admission	8 (2.7%)

FHR: Fetal Heart Rate, CPD: Cephalopelvic disproportion, NICU: Neonatal Intensive Care Unit

Table 4. Comparison of pregnancy outcomes between women with successful and failed intrauterine fetal resuscitation.

Pregnancy outcomes	Success N=155	Failed N=141	p value
Mean birth weight ± SD (years)	3058.0 ± 392.9	3058.1 ± 433.5	0.998
Mode of delivery			< 0.001
Vaginal delivery	124 (80%)	40 (28.4%)	
Instrumental vaginal delivery	2 (1.3%)	17 (12.1%)	
Cesarean section	29 (18.7%)	84 (59.6%)	
Indication for cesarean section (n = 113)			< 0.001
CPD	27/29 (93.1%)	5/84 (6%)	
FHR abnormality	2/29 (6.9%)	79/84 (94%)	
Apgar score < 7			
At 1 min after birth	9 (5.8%)	20 (14.2%)	0.015
At 5 min after birth	0 (0%)	4 (2.8%)	0.05*
NICU admission	1 (0.6%)	7 (5.0%)	0.024*

* Fisher exact test, CPD: Cephalopelvic disproportion, FHR: Fetal Heart Rate, NICU: Neonatal Intensive Care Unit

Various characteristics were compared between women with successful and failed IUFR and the results are shown in Table 5. Significant factors associated with failed IUFR were abnormal FHR during deceleration phase (37.6% vs. 8.3%, p < 0.001), variable deceleration (71.6% vs. 43.2%, p < 0.001), and recurrent variable deceleration pattern (47.5% vs. 18.7%, p < 0.001).

Table 5. Comparison of various characteristics between women with successful and failed intrauterine fetal resuscitation.

Characteristics	Success N=155	Failed N=141	p value
Mean age ± SD (years)	27.3 ± 6.0	28.4 ± 6.7	0.137
Mean gestational age ± SD (weeks)	38.4 ± 1.5	38.4 ± 1.4	0.581
Mean BMI ± SD (kg/m^2)	21.7 ± 4.3	22.2 ± 4.1	0.296
Nulliparous	95 (61.3%)	85 (60.3%)	0.859
BMI category			
Underweight	34 (21.9%)	21 (14.9%)	
Normal	95 (61.3%)	95 (67.4%)	
Overweight	26 (16.8%)	25 (17.7%)	
Complicated pregnancy	20 (12.9%)	27 (19.1%)	0.142
Spontaneous onset of labor	146 (94.2%)	132 (93.6%)	0.836
Spontaneous ROM	50 (32.3%)	52 (36.9%)	0.403
Meconium stained AF	135 (87.1%)	114 (80.9%)	0.142
Time of abnormal FHR			
Latent phase	41 (26.5%)	10 (7.1%)	
Active phase	101 (65.2%)	78 (55.3%)	
Deceleration phase	13 (8.3%)	53 (37.6%)	
Abnormal uterine contraction	10 (6.5%)	5 (3.5%)	0.255
Minimal FHR variability	66 (42.5%)	43 (30.5%)	0.031
Deceleration			< 0.001
Early	39 (25.1%)	7 (5.0%)	
Late	49 (31.6%)	33 (23.4%)	
Variable	67 (43.2%)	101 (71.6%)	
Characteristic of NICHD category II			< 0.001
Prolonged deceleration	58 (37.4%)	45 (31.9%)	
Recurrent variable deceleration	29 (18.7%)	67 (47.5%)	
Minimal variability	46 (29.7%)	11 (7.8%)	
Others	22 (14.2%)	18 (12.8%)	

BMI: body mass index, ROM: rupture of membranes , AF: amniotic fluid, FHR: fetal heart rate, NICHD: National Institute of Child Health and Human Development

Logistic regression analysis was performed to determine independent associated factors with failure of IUFR and the results are shown in Table 6. After adjusting for age, parity, BMI, abnormal uterine contraction, and FHR variability, only time of abnormal FHR and characteristics were the

independent associated factors. Abnormal FHR during active phase and deceleration phase significantly increased the risk of failed IUFR (adjusted OR 2.85, 95%CI 1.28-6.37 and 13.51, 95%CI 5.08-35.71, respectively). Both late and variable deceleration patterns also increased the risk (adjusted OR 3.37, 95%CI 1.18-9.52 and 6.29, 95%CI 2.35-16.95, respectively).

Table 6. Logistic regression analysis to determine independent risk factors associated with failure of intrauterine fetal resuscitation.

Factors	Adjusted OR	95%CI	p value
Time of abnormal FHR			
Latent phase	1.0		
Active phase	2.85	1.28-6.37	0.01
Deceleration phase	13.51	5.08-35.71	< 0.001
Deceleration			
Early	1.0		
Late	3.37	1.18-9.52	0.023
Variable	6.29	2.35-16.95	< 0.001

Adjusted for age, parity, BMI, abnormal uterine contraction, FHR variability
OR: odds ratio, CI: confidence interval, FHR: fetal heart rate

Discussion

Non-reassuring FHR patterns may be indicative of impaired fetal oxygenation and when progressive may lead to fetal hypoxia, which is associated with hypoxic-ischemic encephalopathy or even fetal death. Abnormal FHR pattern in NICHD category II and III have been reported to increase the risk of neonatal hypoxia, low Apgar scores, neonatal resuscitation and intrauterine fetal death[1, 2, 8]. Therefore, appropriate and timely intervention is indicated to optimize neonatal outcome. It is recommended that NICHD category II FHR patterns require evaluation, continued surveillance, initiation of appropriate corrective measures when indicated, and reevaluation[3]. Many measures for IUFR to promote fetal well-being in such conditions have been proposed, including provision of maternal oxygen, change in maternal position, discontinuation of labor stimulation, treatment of maternal hypotension, and amnioinfusion[1-6]. However, the success rate and effectiveness of such IUFR interventions have yet to be evaluated.

All women in this study received the same IUFR technic, including changing maternal position to lateral recumbent position, maternal oxygen supplementation, intravenous fluid administration, and reduction or discontinuation of uterine stimulation as appropriate. Maternal repositioning could avoid compression of maternal great vessels and improves utero-placental perfusion and could alleviate umbilical cord compression. Intravenous fluid administration can improve maternal hypovolemia and increase utero-placental perfusion. Reduction or discontinuation of uterine stimulation can reduce uterine tachysystole and subsequent fetal hypooxygenation. Maternal oxygen supplementation can increase oxygen transfer to fetal umbilical vein[3, 6].

Although such measures are generally acceptable in clinical practice to improve the metabolic condition of their fetuses and alleviate the abnormal FHR patterns, there is still no strong evidence on the effectiveness of each technique[5, 7]. There are some debates on the benefits of maternal oxygen supplementation. Previous reviews reported that the use of maternal oxygen supplementation in laboring women did not show significant benefit to the fetus. Moreover, by increasing

free radical activity, maternal oxygen supplementation may even be harmful[10, 11] . A more recent systematic review also did not find a strong evidence to support the use of maternal hyperoxygenation for fetal distress[7]. A recent clinical trial demonstrated that room air was non-inferior to maternal oxygen supplementation for IUFR among women with NICHD category II FHR pattern[12].

The results of this study showed that the success rate of IUFR measures among women with NICHD category II FHR patterns was 52.4%. Failure rate of IUFR was significantly higher when abnormal FHR was in the pattern of recurrent variable deceleration. Strongest associated factors for failure of IUFR were the occurrence of abnormal FHR pattern in deceleration phase and those with variable deceleration. This could possibly be due to the severity and causes of FHR abnormality that could not be alleviated from the given IUFR measures.   In addition, during deceleration phase, stress to the mothers and fetus could have been increased after they went through the process of labor and those with inadequate oxygen reserve could easily be compromised. Failed IUFR also significantly increased risk of adverse outcomes, including cesarean delivery, birth asphyxia, and NICU admission. Although the results were from univariate analysis, they provided some information on the relationship between failed IUFR and adverse neonatal outcomes. Results of IUFR could help indicating the severity of fetal compromise and the presence of fetal acidemia should be considered. Therefore, when IUFR measures failed, appropriate and timely additional interventions are needed to minimize adverse neonatal outcomes.

The results were similar to many previous studies that certain abnormal FHR patterns of decelerations or variability were associated with adverse neonatal outcomes[2, 6]. In terms of timing of occurrence, a previous study reported an increase in neonatal morbidity, including birth asphyxia and NICU admission, in NICHD category II FHR pattern, especially during the last 2 hours before delivery[8]. With regard to characteristics of FHR abnormalities, late decelerations have been associated with fetal metabolic acidosis and hypoxic-ischemic encephalopathy[13]. Another study also showed that FHR variability in the presence of late or variable decelerations was the most consistent predictor of newborn acidemia[14]. A more recent study reported that deceleration frequency and severity were predictive of acidemia independent of the NICHD categories. In addition, within the NICHD-defined EFM features, repetitive prolonged decelerations, tachycardia, recurrent variable decelerations, and recurrent late decelerations were identified as predictors of acidemia[15].   On the other hand, the presence of FHR accelerations or moderate FHR variability or both should also be evaluated since they are highly predictive of normal fetal acid-base status and may help guide clinical management[3, 14].

The strength of this study included that all women received similar care during labor and IUFR measures according to institutional guideline There are some limitations of this study to be addressed. Effectiveness of each technique of IUFR could not be evaluated. Amnioinfusion, which is another technique for IUFR is not routinely performed in our institution that the estimated success rate of IUFR might change if such technic is adopted. The success rate might also be related to some factors which are not measurable. The degree of actual fetal acidemia, such as umbilical artery pH, could not be evaluated since this is not included in routine practice and adverse neonatal outcomes were measured only from clinical status.

Understanding the success rate of IUFR measures for NICHD category II FHR patterns and associated factors would help caring obstetricians aware of the degree of fetal compromise which could lead to better decision and initiate timely interventions to improve neonatal outcomes. As controversies still exist, further studies are still needed in various aspects of management of NICHD category II FHR patterns, as well as the most appropriate IUFR measures and their effectiveness.

Conclusion

Success rate of intrauterine fetal resuscitation in NICHD category II FHR patterns was 52.4%. Factors

significantly associated with success rate were timing of abnormal FHR and characteristics of deceleration.

Potential conflicts of interest

The authors declare no conflict of interest.

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