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Original Research

STUDY SOME CHARACTERISTICS OF ELECTRONIC FETAL MONITORING TO DIAGNOSE FETAL COMPROMISE

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ABSTRACT

Background: *Assessing fetal health during pregnancy and labor is important in reducing neonatal morbidity and mortality. In which electronic fetal monitoring is the most commonly used obstetric procedure. The false-positive rate of electronic fetal monitoring to predict adverse outcomes is high. Therefore, the study of fetal heart rate charts to confirm the diagnosis of fetal compromise is very necessary to limit cases of unreasonable cesarean section. Therefore, we conduct this study to: (1) Survey the characteristics of electronic fetal monitoring (EFM) to diagnose fetal compromise. (2) Find out the association between EFM and obstetrical outcomes*

Methods: *Observative cross-sectional study recruited 336 term singleton pregnant women with occipital presentation, presenting with labour symptoms at Department of Obstetrics and Gynecology, Hue University of Medicine and Pharmacy, between June 2019 to June 2021. All participants accepted to participate in the research and fetal being was assessed by EFM using FIGO 2015 classification. Exclusion criteria were multiple gestation, congenital malformation, placenta previa, placenta abruptio, maternal disease affecting the fetus and using medication which can affect the fetus.*

Results: *Among 336 pregnant women, 31 cases (11%) were diagnosed with fetal compromise. Deceleration had the highest sensitivity while baseline heart rate had the lowest to diagnose fetal compromise. Base line heart rate had the highest specificity while acceleration had the lowest to diagnose fetal compromise. There was an association between EFM and Neonatal Intensive Unit Care admission (p<0.001). There was no association between EFM and gestational age, birth weight, nuchal cord, amniotic fluid's color and first-minute APGAR score.*

Conclusions: *EFM should be indicated for labour women to screen the fetal compromise. However, abnormal EFM was associated with increased c-section rate, operative delivery and Neonatal Intensive Unit Care admission. Therefore, close monitoring should be combined with clinical and subclinical results to prevent unnecessary intervention.*

Keywords: *Electronic fetal monitoring (EFM), fetal compromise.*

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I. INTRODUCTION

Assessing fetal health during pregnancy and labor is important in reducing neonatal morbidity and mortality. In which, electronic fetal monitoring is the most commonly used obstetric procedure [1]. This method record both fetal heart rates and uterine activity to assess fetal health to intercede on time before any adverse outcomes happen.

In 1958, Hon published data about 80 women who were monitored FHR via abdominal wall [2]. Then this fetal health assessment has been applied to practice in developed countries since the late 1960s and Vietnam since the late 1990s. In 1977, monitoring was implemented in 54% labours in USA, and this rate increased to more than 85% in 2004 [1,3].

Since practicing, they have confirmed the significant roles of monitoring FHR in fetal health assessment, especially during labour, to detect abnormal EFM and uterine contractions to avoid acute and severe fetal compromise. Therefore, nowadays, EFM is indicated for most pregnant women.

There were many EFM categories, for instance: FIGO (1987), RCOG (2001), ACOG (2009). In 2015 November, FIGO released the consensus guidelines on intrapartum fetal monitoring after 3 years of consulting experts from other associations, including RCOG, ACOG, and ICM [4]. In fact, many abnormal EFM was diagnosed as an acute fetal compromise, but the Apgar scores were normal. Besides, the false-positive rate of EFM to predict fetal compromise is high. Therefore, the study of fetal heart rate charts to confirm the diagnosis of fetal compromise is very necessary to limit cases of unreasonable cesarean section. Therefore, we conduct this study to survey the characteristics of electronic fetal monitoring (EFM) to diagnose fetal compromise; and find out the association between EFM and obstetrical outcomes.

II. MATERIALS AND METHOD

An observational cross-sectional study recruited 336 term singleton pregnant women with occipital presentation, presenting with labour symptoms at Department of Obstetrics and Gynecology, Hue University of Medicine and Pharmacy, between June 2019 to June 2021. All participants accepted to participate in the research and fetal being was assessed by EFM using FIGO 2015 classification.

Exclusion criteria were multiple gestation, congenital malformation, placenta previa, placenta abruptio, maternal disease affecting the fetus and using medication which can affect the fetus.

2.2. Methodology

2.3. Conducting research

The 2015 FIGO intrapartum cardiotocography (CTG) classification system [4].

Table 1: The 2015 FIGO intrapartum cardiotocography (CTG) classification system

	Normal CTG[a]	**Suspicious CTG**	**Pathological CTG**
Baseline[b]	110-160 bpm	Lacking at least one of normal characteristics, but with no pathological features	<100 bpm
Variability[c,d,j]	5-25 bpm		Reduced/increased variability[c,d]; sinusoidal pattern[j]
Decelerations[e,f,g,h,i]	No repetitive* decelerations		Repetitive* late or prolonged decelerations for >30 min (or >20 min if reduced variability); one deceleration >5 min
Interpretation	No hypoxia/acidosis	Low probability of hypoxia/acidosis	High probability of hypoxia/acidosis

CTG category II or suspicious CTG and CTG category III or pathological CTG are abnormal CTG.

Fetal compromise criteria based on Instruction of diagnosis and treatment by Ministry of health (2015) [6] and FIGO's guildline 2015 [4]: green amniotic fluid (rupture of membranes or amniotomy) and pathological CTG (FIGO 2015 classification system): (1) variability < 5bpm in > 50 minutes, or >25bpm in >30min; (2) repetitive late deceleration (DIP II) or repetitive prolong deceleration in >30 minutes record (>20 minutes if decrease variability); (3) Deceleration longer than 5 minutes; (4) sinusoidal trace CTG > 30 minutes.

2.4. Analyze data

Input and analyze data by SPSS 20.0. Qualitative variables: expressed as frequency (n) and percentage (%). Quantitative variables were described in the study population with means and standard deviations (SD) or median, min and max, and draw a graph.

Use Chi - square test to verify the association between two qualitative variables and the mean values. When the expected frequency below 5 is greater than 20%, use Fisher's Exact Test to verify the relationship between two qualitative variables. The comparisons are statistically significant when $p < 0.05$.

III. RESULTS

3.1. Characteristics of EFM in fetal compromise diagnosis

Table 2: Fetal compromise rate and baseline FHR

Baseline	Cases	Fetal compromise	%
<110 bpm	2	1	50,0
110-160 bpm	322	27	8,4
>160 bpm	12	9	75,0
Total	336	37	11,0
p < 0,001			

The percentage of fetal compromise in the bradycardia group was 50%, in the normal baseline group was 8.4% and in the tachycardia group was 75%. This difference was statistically significant with $p < 0.001$.

Table 3: Fetal compromise rate and baseline variability

Variability	Cases	Fetal compromise	%
< 5 bpm	31	15	48,4
5 – 25 bpm	304	22	7,2
>25 bpm	1	0	0
Total	336	37	11,0
p < 0,001			

The proportion of fetal compromise in minimal variability was highest at 40,5%. This difference was statistically significant with $p < 0.001$.

Table 4: Fetal compromise rate and baseline variability

Acceleration	Cases	Fetal compromise	%
Yes	198	13	6,6
No	138	24	17,4
Total	336	37	11,0
p = 0,002			

The percentage of fetal compromise in the group with and without acceleration was 6,6% and 17,4%, respectively. This difference was statistically significant with $p < 0.05$.

Table 5: Fetal compromise rate and deceleration

Deceleration	Cases	Fetal compromise	%
Early deceleration	137	10	7,3
Late deceleration	45	14	31,1
Variable deceleration	24	4	16,7
Prolong deceleration	9	4	44,4
No deceleration	121	5	4,1
Total	336	37	11,0
p < 0,001			

The proportion of fetal compromise was the highest when prolonged deceleration was present, at 44,4%. This difference was statistically significant with $p < 0.001$.

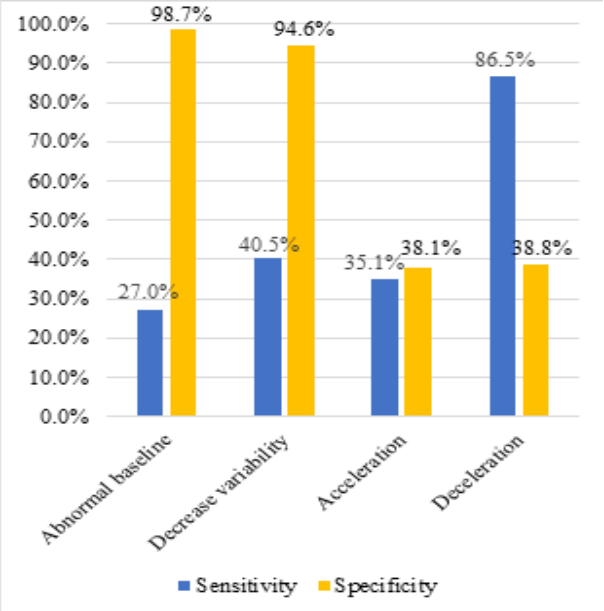

Chart 1: Sensitivity and specificity of CTG features to diagnose fetal compromise

Deceleration has the highest sensitivity and baseline fetal heart rate has the lowest sensitivity in fetal compromise diagnosis.

Abnormal baseline FHR has the highest specificity and acceleration has the lowest specificity in fetal compromise diagnosis.

3.2. Association between EFM and pregnancy outcomes

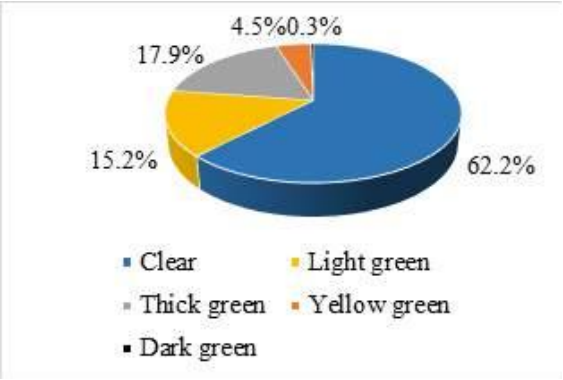

Chart 2: Proportion of amniotic fluid color

The group with clear amniotic fluid was highest at 62,2% and the group with dark green amniotic fluid was lowest at 0,3%.

Table 6: Association between CTG and amniotic fluid color

CTG \ Fluid color		Clear		Green		P
		n	%	n	%	
CTG category	I	84	69,4	37	30,6	0,092
	II	88	59,9	59	40,1	
	III	37	54,4	31	45,6	
Total		209	62,2	127	37,8	

The percentage of clear amniotic fluid was lower in the normal CTG category (I), green amniotic fluid was higher in the abnormal CTG category (II, III). However, this difference was not statistically significant, with $p > 0.05$.

Table 7: Association between CTG and types of delivery

CTG \ Types of delivey		Vaginal delivery		Cesarean delivery		P
		n	%	n	%	
CTG category	I	91	75,2	30	24,8	0,001
	II	87	59,2	60	40,8	
	III	33	48,5	35	51,5	
Total		211	62,8	125	37,2	

The rate of vaginal delivery decrease and cesarean delivery increase when CTG become abnormal. The C-section rate in CTG categories I, II, III was 24.8%, 40.8% and 51.5%. This difference was statistically significant with $p < 0.05$.

Table 8: Association between CTG and first-minute Apgar score

CTG category	Apgar ≥ 7		Apgar < 7		Total	
	n	%	n	%	n	%
Category I	121	100	0	0,0	121	36,0
Category II	143	97,3	4	2,7	147	43,8
Category III	66	97,1	2	2,9	68	20,2
Total	330	98,2	6	1,8	336	100
p = 0,120						

Neonates with first-minute Apgar ≥ 7 account for the highest number, at 98.2%. First-minute Apgar < 7 in CTG category I, II, III groups are 0.0%, 2.7% and 2.9%, respectively. This difference was not statistically significant, with $p > 0.05$.

Table 9: Association between CTG and neonates admitted to NICU

NICU admited / CTG category	Yes		No		Total	
	N	%	n	%	n	%
Category I	1	4,8	120	38,1	121	36,0
Category II	9	42,8	138	43,8	147	43,8
Category III	11	52,4	57	18,1	68	20,2
Total	21	100	315	100	336	100
p < 0,001						

The rate of neonates admitted to NICU increased when CTG became abnormal. This number for each CTG category I, II, III: 4.8%, 42.8% and 52.4%. This difference was statistically significant with $p < 0.001$.

IV. DISCUSSION

4.1. Characteristics of study samples

Our study included 336 cases, 37 were diagnosed as fetal compromise (11%). The diagnosis of fetal compromise was: green amniotic fluid, pathological CTG (FIGO 2015).

There are many studies about fetal compromise domestically and internationally, and the results differ depending on the objectives, method of analysis, and the authors' assessment. Adanikin et al study in 2017, the fetal compromise rate was 233/1000 lived neonates [7], higher than our study. However, many authors conduct their survey in referral hospitals and the criteria to diagnose fetal compromise by Pinard horn. Gangwar and

associates' (2016) studied pregnant women who underwent C-section due to fetal compromise was having abnormal CTG; the proportion of fetal compromise was 14.38% [8]. According to Ngoc P.T.H (2014), the fetal compromise percentage was 12.4%, yet the author only included abnormal CTG and assessed fetal compromise based on Apgar score [5]. In another study by Dung V.D.H (2006), fetal compromise proportion in non-reassuring CTG after monitoring and intervention was 9.7% [9]. Compared to other authors, the fetal compromise rate in our study is similar, including labours with normal and abnormal CTG. Still, our criteria to diagnose fetal compromise is more strict and needs more factors.

4.2. Characteristics of EFM in fetal compromise diagnosis

In our study, decelerations had the highest sensitivity (86.5%), while abnormal baseline, baseline variability and acceleration had lower sensitivity (<50%) in fetal compromise diagnosis.

Abnormal baseline FHR and decreased variability have the highest specificity (at 98.7% and 94.6%, respectively), which means if CTG has a normal baseline and variability, the fetal compromise rate will be lower [4,12] because myocardium maintains baseline controlling by the brain, and normal variability reflecting the intact of the autonomic nervous system (the sympathetic and the parasympathetic). Therefore, normal baseline and variability mean that the oxygen for central organs (heart and brain) is sufficient [13].

4.3. Association between EFM and labour outcomes

Association between EFM and amniotic fluid color: Amniotic fluid is typically colorless or slightly yellow when it is full term. Meconium in amniotic fluid or green amniotic fluid is a sign of fetal distress. The intensity of the color depends on the time it takes meconium to be ejected into the amniotic cavity. When the amniotic becomes darker, that means meconium is being expelled, and the fetus is at risk of hypoxemia.

Chart 2 shows that in our study, the clear amniotic fluid group is 62.2%,s and the dark green amniotic fluid is 0.3%. Table 6 illustrates that the proportion of clear fluid is lower, while the stained amniotic fluid is higher in abnormal CTG cases. The percentage of stained amniotic fluid in CTG category I, II, III groups are 30.6%, 40.1% and 45.6%, respectively. These differences are not statistically significant, with $p > 0.05$.

This result is similar to Ngoc P.T.H's study (2014) on 105 pregnant women who had abnormal CTG: clear amniotic fluid accounted for 44.8%, and dark green fluid accounted for 5.7%. In CTG category II group: clear fluid is 46.1%, and dark green fluid is 4.9%. In CTG category III group, thick green fluid is 66.7% and dark green fluid is 33.3%[5]. Nhan H.B's study (2012) showed that in 32.6% of abnormal CTG, the thick green fluid accounted for the highest at 58.8%.

Anand's study (2016) showed that the rates of clear fluid decreased while the green fluid increased from normal to abnormal CTG. The percentage of green amniotic fluid in CTG category I, II, III groups was 16%, 19% and 65% respectively. This differences are statistically significant with $p < 0.05$ [15]. Other authors categorize characteristics of meconium in amniotic fluid, as dilute, medium and thick [16,17] or 3 level I, II, III [18,19], or thick and delute meconium stained [15,20-22].

Many studies recorded abnormal CTG rate higher in meconium stained amniotic fluid. However, abnormal CTG in these cases was not adequate to assess fetal health. Vijayasree's study (2014) revealed significantly higher rate of abnormal CTG in meconium stained amniotic fluid group (34%) than in the clear fluid group (6%) [22]. Odongo et al study (2010) showed that suspicious and pathological CTG increased noticeably in meconium stained amniotic fluid group than in clear amniotic fluid (RR 1.490, 95% CI: 0.928 – 2.393) [23].

Meconium stained amniotic fluid is an important sign of fetal compromise, which increase neonatal morbidity and mortality. No specific CTG feature in meconium stained amniotic fluid group has high adverse outcomes predictive value. Decision-making should be based on the clinical situation, stage of labour and the process of labour [24].

The association between CTG types of delivery: Anand's study (2016) showed that C-section rate in CTG category I, II, III was 9.5%; 60% and 76%, respectively [15].

Banu's study (2015) showed that the Cesarean section rate in CTG category II was 73.9%, and III was 81.8% [25]. Desai's study (2017) had a similar result, CTG category III had the highest C-section rate at 46.5%, while the figures for category I and II were 33.7% and 19.8%, respectively [24].

These studies demonstrate that C-section rate increased proportionally to the CTG category, and was highest at category III CTG.

CTG observes fetal heart rate and uterine activity to detect abnormal fetal heart rate associated with fetal compromise. Using CTG widely helps decrease and prevent morbidity and mortality of neonates by predicting fetal hypoxia, especially brain damage. This procedure has some restrictions as low PPV (30%) and high false-positive rate (60%) in the diagnosis of fetal compromise, increased unreasonable C-section rate, and operative vaginal delivery [13]. This unnecessary intervention will harm both mother and child. Therefore, the clinical situation should be considered before any intervention.

Association between CTG and 1-minute Apgar score: Nhan H.B (2012) and our study have similar results. First-minute Apgar < 7 in CTG category I is lowest at 4.5% and highest in category III at 12.5% [16]. Ngoc P.T.H (2014) noted that first-minute Apgar < 7 in CTG category III was higher than category II (100% and 9.8%) [5]. Anand's study (2016) indicated that the first-minute Apgar < 7 in CTG category I was 6.4%; category II was 40%, and category III was 92%. This differences are statistically significant with p < 0,001 [17].

In our study, the rate of first-minute Apgar < 7 is low, which could be explained by the high sensitivity of CTG to discover cases earlier, and with low specificity (34.8%), most of these cases' outcomes were good.

Apgar scores provide an acceptable and convenient method to predict neonates' status after birth and resuscitation if needed. Apgar should not be considered as evidence or consequence of asphyxia, or to predict mortality and nervous system complication. Apgar scores after resuscitation should not be compared with natural respiration. AAP and ACOG recommended using an expanded Apgar score reporting form that accounts for concurrent resuscitative interventions [28].

Association between CTG and follow-up neonates at NICU: Table 9 shows that the number of neonates admitted to NICU is 6.2%, increasing gradually from normal CTG to abnormal CTG: 0.8% in category I, 6.8% in category II and 16.2% in category III. This difference was statistically significant with p < 0.05.

V. CONCLUSION

CTG should be indicated for all pregnant women labouring to screen for fetal abnormalities. However, abnormal CTG is associated with higher C-section rates, operative vaginal delivery rates, and NICU-admitted neonates.

Therefore, when abnormal CTG is detected, clinical situations, laboratory tests, and strictly following up to make a decision and avoid unnecessary intervention.

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