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CLINICAL STUDY ON FETAL HEART RATE MONITORING IN DETECTING FETAL DISTRESS IN PREGNANT WOMEN IN LABOR

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ABSTRACT

Aim: To assess the reliability of continuous fetal heart rate monitoring in detecting fetal distress in pregnant women in labor.

Materials and methods: In our prospective study, term patients who were admitted in latent or active phase of labor in CKM hospital, were subjected to intra-partum fetal heart monitoring with cardio-toco-graph.

Results: Average age group of our study population was 23 years, average gestational age- 39 weeks and average neonatal birth weight was 3.04 kgs. 6% normal, absent variability in 33%, minimal variability in 40%, moderate variability in 17%, and sinusoidal pattern was observed in 4%. All the abnormal CTGs were divided according to NICHD into 3 categories and 6% had category I CTG, 58% had category II CTG and 36% had category III abnormal CTG of 100 women. Out of 36 women categorized under NICHD III, 27(75%) had intra-op abnormalities and the association was significant, while out of 58 women with NICHD category II CTG abnormality, 17(29%) had abnormal intra-op findings and none of the women with category I abnormal CTG tracings had significant findings. 17(47%) neonates of 36 who had category III abnormal tracing intra-partum, had APGAR </= 7 which was statistically significant and 5(8%) neonates of 58 with category II tracing, had APGAR </= 7. 29 of 36(80%) neonates who had category III tracing intra-op required NICU admission which was statistically significant and 11 of 47(24%) neonates with category II required admission.

Conclusion: Electronic fetal monitoring is a useful intrapartum tool, if used judiciously and according to evidence-based guidelines and can be used to improve perinatal outcomes.

Keywords: Electronic fetal monitoring, perinatal outcomes, sinusoidal pattern

INTRODUCTION

The principal aim of intrapartum fetal surveillance is to prevent adverse perinatal outcomes arising from fetal metabolic acidosis and cerebral hypoxia related to labor. However, many factors contribute to the development and severity of an asphyxial injury (e.g. tissue perfusion, tissue substrate availability, the duration and severity of the insult, the fetal condition prior to the insult) such that the relationship between metabolic acidosis and cerebral damage is complex. The degree of tissue damage and subsequent injury may not necessarily relate directly to the extent of fetal metabolic acidosis arising during labor. Nonetheless, the practice of fetal surveillance during labor would detect those fetuses at risk of compromise, allowing appropriate intervention and thereby increasing the likelihood of favorable perinatal outcomes. Monitoring the health of the fetus during labor has therefore become a key component of modern maternity care. Traditionally, this was undertaken by simple regular auscultation of the fetal heart with a stethoscope. However, this approach was considered by many to be inadequate, particularly for women with identifiable risk factors in their pregnancies. Therefore, in an effort to reduce the incidence of intrapartum fetal mortality and morbidity, the use of intrapartum electronic fetal monitoring (EFM), particularly continuous CTG, has steadily increased over the last 35 years.[1]

The hypothesis behind the use of continuous fetal heart monitoring/CTG is that the integrity of the autonomic nervous system is a prerequisite for a healthy fetus, the CNS being responsible for controlling the FHR. The exact mechanism is unknown, but it is proposed that hypoxemia and acidemia induce an alteration of the brain stem centers which are regulating the activity of the pacemaker cells of the heart, there by altering the fetal heart rate patterns on CTG trace.

Cardiotocography (CTG) (kardia meaning heart, tokos meaning labor/childbirth) is the continuous electronic record of fetal heart rate (FHR) and Uterine activity, which is obtained by two transducers placed on the abdomen of the mother and having a simultaneous graphic representation of both on paper. CTG is the most widely used fetal surveillance technique utilized for assessing fetal well-being during the antenatal period and labor and plays an important role in diagnosing non-reassuring fetal status during labor. CTG traces are interpreted according to the three-tier fetal heart rate interpretation system recommended by 2008 National Institute of Child Health and Human Development NICHD workshop - Category I (Normal), Category II (Indeterminate) and category III (Abnormal) .[2]

Fetal hypoxia in labor causes ischemic encephalopathy (HIE) and in severe cases, irreversible brain injury. Greater degrees of ischemia may lead to seizures, cerebral palsy and mental retardation (2). However, the abnormal cardiotocographic traces always may or may not translate into intraoperative findings of meconium-stained liquor or low APGAR at birth. Suspected fetal distress detected by cardiotocographic (CTG) has been the most common indication for cesarean section (CS) for the past few decades. Many fetuses show heart rate changes without being adversely affected and CTG has been criticized to create an unnecessary high rate of operative deliveries (3, 4, and 5). Hence, a study is warranted to understand their

correlation, thereby demonstrating the utility of cardiotocographic in diagnosing non-reassuring fetal status.

MATERIALS AND METHODS

Main source of data for this study are booked and unbooked cases at CKMH, Warangal. Study was conducted from December 2019 to December 2021 on cases with singleton pregnancies and term gestation and who were admitted for safe institutional delivery at CKMH, Warangal. Detailed information will be elicited with special reference to the category of abnormal CTG and perinatal outcome with reference to need for neonatal resuscitation, APGAR at 5 min, need for NICU admission and neonatal complications.

Inclusion Criteria: Singleton pregnancies, Cephalic presentation, Live birth, Gestational age ≥ 37 weeks, No fetal anomalies**,** Non-reassuring fetal heart rate patterns detected by CTG not responding to conservative management and Caesarian section delivery.

Exclusion Criteria: Congenital anomalies, abnormal presentation, multiple gestation, gestational age<36 weeks, intrauterine Growth Restriction (IUGR), pregnancies associated with medical disorders and cesarean delivery for other primary indications.

Patients who were admitted in latent phase of labor and were subjected to cardiotocography in the labor room, satisfying all the inclusion criteria and underwent cesarean section were selected. Demographic details of the patients were noted. The cardiotocograph traces of each patient were noted with respect to baseline fetal heart rate, variability, acceleration and types of deceleration. These CTG were categorized into NICHD I, II and III.

Intra-operative findings of all the 100 patients were noted and the perinatal outcome with reference to need for resuscitation at birth, APGAR at 5 min, need for NICU admission, duration of NICU admission and neonatal complications were noted. Other details like birth weight of the baby were also noted.

RESULTS

Table-1: Characteristics of study population

Characteristics	
Age	23.1(18-34)
Gestational age	39(37-42)
Gravida	1-5
Para	0-2
Neonatal birth weight	3.04(1.9-4.2)

A univariate analysis was done for some of the characteristics of the woman in our study (Table 8), the mean age of the women in the study was 23.1 years which ranged from 18 – 34 years. The women had term pregnancies ranging from 37 to 42 weeks with a mean gestation age of 39 weeks. 48% were primi gravida and 67% were nulliparous. Among the 100 women in the study, 57 required augmentation with inj. Oxytocin.

Table -2: Baseline Fetal Heart Rate

Fetal heart	**Frequency**	**Percentage**
Bradycardia	**63**	**63**
Normal	**5**	**5**
Tachycardia	**32**	**32**
Grand total	**100**	**100**
Baseline Variability Intrapartum		
Absent	**33**	**33**
Minimal	**40**	**40**
Moderate	**17**	**17**
Normal	**6**	**6**
Sinusoidal	**4**	**4**
NICHD category		
I	6	6
II	58	58
III	36	36

Of the total babies born to the women in the study, 63% had bradycardia, 5% had normal heart rate, 32% had tachycardia intrapartum. In the study among the 100 women, 33% had absent variability, 40% had minimal variability, 17% had moderate variability, 6% had normal variability, 4% had sinusoidal pattern of variability in the cardiotocograph intrapartum. Of the 100 women, cardiotocograph of 58% was under NICHD category II, 36% was under category III, 6% fell under category I.

Table -3: Intraoperative Findings

Intra Operative Findings	**Frequency**	**Percentage**
None	56	56
Nil liquor	13	13
2 Loops of Cord Around Neck	5	5
MSL	16	16
MSL,2 Loops of Cord Around Neck	3	3
Single Loop of Cord Around Neck	7	7

Grand Total	100	100

No significant Intra operative findings were found in 56% women, 5% had 2 loops of cord around the neck of the baby, 16% had MSL, 3% had MSL & 2 loops of cord around the neck, 7% had single loop of cord around the neck.
Neonatal resuscitation was required in 46% and 54% neonates did not require resuscitation.

Table -4: APGAR at 5 min and complications

APGAR 5min	**Frequency**	**Percentage**
4	1	1
6	7	7
7	14	14
8	18	18
9	17	17
10	43	43
Complications		
HIE	**4**	**4**
RDS	**7**	**7**
Nil	**89**	**89**

43% of the neonates had APGAR 10 at 5 minutes and 22% had APGAR of 7 or less.
40% neonates required NICU admission and duration of admission range from 1 to 15 days. Neonatal complications HIE was seen in 4 neonates and RDS is seen in 7 neonates.1 neonatal mortality was observed.

Table-5: Association between NICHD category and APGAR at 5 min

NICHD	**APGAR**		**Total**	**P - value**
	Less than or equal to 7	**Greater than 7**		
1	**0**	**6**	**6**	
11	**5**	**53**	**58**	**0.00002**
111	**17**	**19**	**36**	
NICU admissions				
1	**0**	**6**	**6**	
11	**11**	**47**	**58**	**<0.00001**
111	**29**	**7**	**36**	
Neonatal complications				

1	**0**	**6**	**6**	
11	**17**	**41**	**58**	**<0.00001**
111	**27**	**9**	**36**	

Out of the 36 women who had category III CTG tracing intrapartum according to NICHD, 17 women had neonates with APGAR </= 7 at 5 min (p-value – 0.0002) and 5 out of 58 women with category II tracing had APGAR</= 7. Out of the 36 neonates who had category III NICHD fetal heart tracing intra-partum, 29 required admission to the NICU (p value - <0.0000001) and 11 out of 58 women with category II tracing required admission.

Out of all NICU admissions, more admissions were observed from the category III subgroup i.e., 9 out of 36. (p-value – 0.003) while 2 of 58 neonates from category II abnormal tracing required admission.

Table-6: association between NICHD catageory and intra operative complications

	Intra opertaitve Findings		**Total**	**P - value**
NICHD	**Present**	**Absent**		
1	0	6	6	
11	17	41	58	<0.00001
111	27	9	36	

Out of the 36 women who had category III fetal heart tracing on CTG, 27 women had intra-op findings like MSL, nil liquor or loops of cord around neck (p-value 0.0000001) and 17 of 58 women from category II had significant intra-op findings

Table-7: association between intra operative findings and Neonatal admissions , resuscitation.

NICU admissions	**Present**	**Absent**	**Total**	**P value**
Present	30	14	44	
Absent	10	46	56	0.00002
Neonatal resuscitation				
Present	29	15	44	
Absent	17	39	56	0.00002

30 of 44 Neonates with significant intra-op findings required admission into the NICU (p-value- 0.0000001)

Neonates of 29 women out of 44 required resuscitation (p-value 0.0002), while neonates of 17 women out of 56 required resuscitation.

Table-8: Association between CTG variability and NICU admission

NICHD	**Findings**		**Total**	**P – value**
	Present	**Absent**		
NICU admission				
Absent	26	7	33	
Minimal	7	33	40	
Moderate	4	13	17	0.000001
Normal	0	6	6	
Sinusoidal	3	1	4	
APGAR				
Sinusoidal	0	4	4	
Neonatal complications				
Absent	9	24	33	
Minimal	1	39	40	0.008
Moderate	1	16	17	
Normal	0	6	6	
Sinusoidal	0	4	4	

Out of the 33 women who had absent variability on CTG, neonates of 26 women required admission (p-value < 0.05). Neonates of 17 women out of 33 women with absent variability had APGAR </= 7.(pvalue 0.00001). 9 out of 33 neonates who had absent variability on CTG had complications (p-value 0.008).

DISCUSSION

Intrapartum fetal heart rate abnormalities occurring in presence of uterine contractions can be the reflection of placental circulation and fetal tissue perfusion. Intrapartum fetal surveillance can be done by various methods. Electronic fetal monitoring using cardiotocography (CTG) is a simple option available. The CTG trace was described according to NICHD 2008 classification. For identification of intrapartum asphyxia, sensitivity of this EFM was found to be 93% and positive predictive value was just 3-18%.[3] A study by Ray et al, found that the indeterminate (category II CTG) is seen in 36.5% of laboring women, abnormal (category III CTG) in 13.3% whereas the rest 50.2% of women had normal CTG finding described as category I trace.[4] In the study by

Jackson et al where all the women in labor were evaluated and he found 77.9% of women with category I CTG, 22.2% had category II CTG and only 0.004% with category III CTG.[5] In this study, we evaluated only women undergoing cesarean section for abnormal CTG and found that of the 100 women, cardiotocograph of 58% was under NICHD category II, 36% was under category III, 6% fell under category I. Meconium-stained liquor was found in 49.07% of primigravida who underwent caesarean section due to fetal distress in a study done by Mundhra et al. [6] In another study done in South India the presence of meconium-stained amniotic fluid with abnormal heart rate patterns was 23.8% while clear liquor with abnormal heart rate trace was 37.5%. While in our study 19% patients with abnormal fetal heart rate patterns had MSAF, 13% had nil liqour and 15% had loops of cord around neck.

In our study, presence of meconium-stained liquor was observed more in CTG showing recurrent variable or recurrent late decelerations and also minimal – absent beat to beat variability. There are few studies stating the ominous effect of loss of beat-to- beat variability and its effect on fetal outcome. Hence even persistent low beat to beat variability should be seen with high index of suspicion for fetal distress. But in a study by Desai et al there were 30% of cases with meconium-stained liquor that had reactive CTG trace. [7] Though meconium-stained liquor has a significant association with abnormal CTG in our study, all parameters of a CTG may be normal despite the presence of meconium-stained liquor according to other studies. Therefore, decision to deliver should be based on type of abnormality on CTG trace and presence or absence of other re-assuring features.

In our study when the abnormal CTG is divided into category I, II and III; out of 36% cases having category III CTG 14% had MSAF, 8% had nil liquor, 7% had loops of cord around neck i.e., 27 of 36 cases had some positive intra-operative findings which was statistically significant. (Only 17 cases of 58 cases with category II abnormality had positive intra-op findings). Therefore, when category III CTG abnormality is observed in a patient, there is high chance that the fetus may be in distress due to any of the findings like MSAF, nil liquor, loops of cord around neck and hence decision should be made regarding delivery.

In the study by Gupta et al abnormal CTG was correlated with Apgar score at 5 minute and the mode of delivery in such cases. [8]He found a statistically significant higher number of women with non-reactive CTG who delivered babies with APGAR <7 at 5 minute. In their study the CTG was not categorized according to NICHD classification. In another study by Sunitha.C et al, which was a prospective case control study, they found significantly low Apgar scores at 1 minute in babies who had abnormal CTG trace. [9] In other studies done globally, they found a similar result. (64,65) In our study, 8% of the babies had an Apgar of <7 at 5 minutes and 14% had APGAR=7 at 5 min. Of 36 women that had category III CTG abnormality according to NICHD, 17 neonates had APGAR </= 7 which was statistically significant (p-value 0.00002).

The babies who are depressed at birth usually are admitted in the NICU for monitoring and further evaluation of any sequelae of birth asphyxia. In the study by Sunitha et al, out of total

neonatal admissions to NICU 63.3% belonged to the group with abnormal CTG patterns and rest from normal patterns and it was not statistically significant (p-value 0.5).[9] A similar finding was seen in another study by Gupta et al. [8] Amsumang et al, evaluated women who delivered in a tertiary care 86 centre in Thailand. In their study out of the 120 participants, only 5 babies required NICU admission and they found that the NICU admission rate between the normal and abnormal CTG patterns were not statistically significant.[10] Also, in another study conducted in Srinagar by Sameer et al, neonatal intensive care unit (NICU) admission was needed in 67 (22.3%) patients. When CTG was correlated with NICU admission, 4 (3.7%), 15 (14%) and 48 (57.1%) in Category I, Category II and Category III needed NICU admission. In this study, 40 babies out of 100 were admitted in NICU as they were depressed at birth and had MSAF and required further specialized care. There were 80% (29/36) babies who had a category III CTG trace and 18% (11/58) babies had a category II CTG trace that were admitted and babies with category I tracing have not required NICU admission. We thus found that there was a statistically significant increase in admission to NICU with a category III CTG tracing (p value <0.0000001).

There were various studies evaluating the correlation between CTG abnormalities and neonatal problems like hypoxic ischemic encephalopathy, respiratory distress syndrome, metabolic acidosis, sepsis, etc. Though there were Indian studies evaluating abnormal CTG and its correlation with various factors such as low Apgar, low cord pH and NICU admissions, these studies did not evaluate in detail about the various neonatal problems that the baby encountered during his/her stay in the hospital. In the study by Bagdanovic et al,[11] which was a retrospective analysis of the CTG traces and Apgar score of neonates who were affected with HIE, a statistically significant correlation between pathological CTG and the development of HIE was found. In their study they did not categorise the CTG according to the NICHD classification. In the case-control study by Larma et al, [12] they found a significant increase in incidence of HIE and metabolic acidosis among babies who had an abnormal CTG trace. Similarly other studies have shown a positive correlation between abnormal CTG and adverse neonatal outcome. In our study we did not have a control group with normal CTG trace to compare the correlation of an abnormal CTG with adverse neonatal outcome. However, we found that the number of babies with HIE and RD was higher in the group who had a category III CTG (9/36) than the ones with a category II CTG (2/58), and it was statistically significant (p value 0.0001). This shows that a category III trace have a higher odd of developing neonatal problems when compared to category II. There are various studies which have compared individual components of the CTG and its abnormalities to adverse neonatal outcome. Sunitha et al, found no association between absent beat to beat variability and low Apgar scores/NICU admission or the type of delivery. [9] In the study by Amsumang et al,[10] they found that in the univariate analysis, all the characteristics of the CTG i.e. minimal variability, baseline heart rate and variable decelerations were significantly associated with low Apgar scores and neonatal acidosis, but when the maternal age and gestational age was adjusted for, the association of the various components with Apgar scores was statistically insignificant whereas low cord pH was associated with minimal variability and any variable decelerations which was statistically significant. Larma et al[12] found that the

neonates with HIE had CTG that showed higher rates of bradycardia and decreased variability but no increase in late or variable decelerations. Though bradycardia and decreased variability were associated with HIE, their predictive values were low. [68] In this study we found that absent variability was strongly associated with increased odds of the neonate being depressed at birth thus requiring NICU admission and developed complications. We also looked into recurrent late, recurrent variable decelerations, and their associations with the various neonatal outcomes. We found that recurrent variable decelerations were not associated with low Apgar scores(<7) at 5 minutes but associated with NICU admission. There were 41 babies who had recurrent variable decelerations in the CTG trace of which 19 babies (46%) required NICU admission and 3 babies (7%) developed complications. Similarly, there were 29 babies who had recurrent late decelerations of which 15 babies required NICU admission (51%) and 7 babies developed complications (24%).

CONCLUSION

Using the "fetal monitoring checklist" at the beginning of labor to exclude preexisting hypoxia and developing a deeper understanding of different types of intrapartum hypoxia may help optimize outcomes. The wider clinical context should be always considered. Care should be individualized for each fetus.

It is important to interpret the CTG trace based on a deeper understanding of fetal behavioral states during labor, as well as the features on the CTG trace which differentiate fetal compensatory responses from the onset of decompensation, whilst incorporating the wider clinical context, so that care can be individualized. Electronic fetal monitoring is a useful intrapartum tool, if used judiciously and according to evidence-based guidelines and can be used to improve perinatal outcomes.

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