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Evaluation of cardiotocography (CTG) monitoring for intrapartum fetal surveillance and its correlation with Apgar score

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Abstract
Introduction: Cardiotocography was incorporated in clinical obstetrics to reduce intrapartum mortalityand morbidity. Intrapartum monitoring has infact improved fetal outcome and normal survival is now possible in cases considered hopeless years ago.
Cardiotocography is a simple, safe, non-invasive and economical investigation which can be done on every patient in labour. This test should be a part of intrapartum fetal surveillance. The abnormal pattern of are recognized and necessary and timely intervention is done, thereby saving mother and fetus.
Hence this topic has been taken to evaluate the perinatal outcome following the early recognition of abnormal CTG and early intervention made.
Objective
• The main goal of the study was to correlate abnormal cardiotocography with Apgar score and perinatal outcome.
• To formulate the plan of action depending on the result and to study the outcome of pregnancy.
• To reduce perinatal mortality and morbidity by including cardiotocography as an routine investigation during vaginal delivery.
Materials and methods: The present study is a Simple Random Sampling which includes minimum of 100 term pregnant women in labour with in a period of 6 months with abnormal cardiotocography admitted in the District headquarters hospital, Apollo institute of medical sciences and research, Chittoor.
All women in active labour with singleton, term pregnancy, with cephalic presentation CTG tracings were taken, preferably 30 minutes before delivery or even earlier with FHR irregularities. CTG tracing were defined as non-reassuring and abnormal patterns as per NICE guidelines 2016.Reassuring patterns were excluded from the study. After delivery Apgar score at 1 and 5 minutes were taken. NICU admission were analyzed and followed up till discharge.
Results: Among the 100 patients 48(48%) showed no reassuring FHR patterns, 52(52%) showed abnormal FHR patterns. variable decelerations were commonest abnormal CTG patterns and seen in 32% of cases, next common was tachycardia in 32%, bradycardia in 30%, late deceleration in 22%, 27% of cases delivered vaginally, among them 19% were in the non-reassuring FHR group.
1 min Apgar score < 7 (depressed) was 29.16% and 40.38%% in non-reassuring and abnormal groups respectively. 5 min Apgar score <7 were 7% and 12% in non-reassuring and abnormal groups respectively. Admission to NICU were 13% and 18% in non-reassuring and abnormal FHR groups respectively and 15 perinatal deaths occurred, 4 in cesarean section group and 4 in instrumental vaginal delivery and 7 in vaginal delivery.
Conclusion: In spite of increased operative delivery there was decreased rate of NICU admissions and neonatal deaths providing that early intervention and resuscitation will improve neonatal outcome. Hereby I conclude that Continuous EFM should be offered and recommended for high-risk pregnancies where there is an increased risk of perinatal death.

Keywords: EFM, CTG, APGAR, NICU, FHR

Introduction
The practice of modern obstetrics involves the care of the mother and her fetus. Intrapartum fetal asphyxia is a major risk for neonatal morbidity and mortality. The goal of Intrapartum fetal surveillance is to reduce the incidence of Intrapartum fetal asphyxia and to prevent moderate and severe fetal asphyxia [1]. Various methods have been used to assess Intrapartum fetal distress.

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Currently the two standard methods intermittent auscultation and electronic fetal heart rate monitoring (EFM) by cardiotocograph (CTG) are used. After birth fetal asphyxia is subjectively assessed by Apgar score and objectively by Cord Blood pH [2, 3]. Intermittent auscultation is simple and as safe as continuous EFM [2]. But does not show accurate information about baseline variability or periodic changes. It requires 1:1 auscultate in obese patients [2, 3]. EFM is a non-invasive method and provides information about baseline variability and is a visual sensitive record. Easy to operate, available under any hospital situation, possible to use in the absence of the obstetrician and is financially accessible [3]. Indeed, there were great expectations: [1] that electronic fetal heart rate monitoring provided accurate information, [2] that the information was of value in diagnosing fetal distress, [3] that it would direct intervention to prevent fetal death or morbidity. Hence this study was undertaken to evaluate CTG for prediction and prevention of Intrapartum fetal asphyxia in a single tertiary care obstetric unit. In addition it was studied whether EFM has been associated with increased incidence of operative deliveries and also the neonatal outcomes were noted.

Objectives
1. The main goal of the study was to correlate abnormal cardiotocography with Apgar score and perinatal outcome.
2. To formulate the plan of action depending on the result and to study the outcome of pregnancy.
3. To reduce perinatal mortality and morbidity by including cardiotocography as a routine investigation during vaginal delivery.

Materials and Methods
Study design
This is a simple random sampling study and was conducted in the District headquarters hospital, Apollo institute of medical sciences and research, Chittoor from August 2018 to January 2019. The study has taken the institutional ethics committee approval. 100 pregnant women admitted for delivery with singleton term pregnancy in vertex presentation were taken into the study.

Exclusion criteria
1. Preterm deliveries
2. Twin gestations
3. malpresentations
4. antepartum haemorrhage

A detailed history regarding period of amenorrhoea and obstetric history was taken in a detailed preform. Informed consent was taken. Obstetric examination was done to confirm gestational age, lie, presentation, contractions and fetal heart rate. They were monitored for contractions and fetal heart rate with intermittent auscultation and labor was augmented whenever required. CTG tracings were taken in active stage, preferably 30 minutes before delivery or even earlier with FHR irregularities. Huntleigh-Bd 4000XS machine with external transducer with tocodynometer was used for CTG monitoring. Non-reassuring and abnormal FHR patterns were considered as signs of fetal hypoxia and necessary intervention was done. Following delivery, Apgar score was noted at 1 minute and 5 minutes. The fetal heart rate patterns were analysed according to guidelines of National Institute of Child Health and Human Development

Research Planning Workshop (NICHHD) and National Institute of Clinical Excellence (NICE) 2016 and grouped in to reassuring, non-reassuring and abnormal groups.

Normal: A CTG where all four features fall into the reassuring category.

Suspicious: A CTG whose features fall into one of the non-reassuring categories and the remainder of the reassuring.

Pathological: A CTG whose features fall into two or more non-reassuring or one or more abnormal categories.

Reassuring features: are those with baseline 110-160 bpm, a variability of ≥ 5 bpm with accelerations and absence of deceleration.

Non-reassuring features: Are baseline between 100-109 or 161 to 180 bpm with a variability of <5 bpm for (>40 minutes to< 90 minutes), decelerations of early deceleration, variable deceleration or single prolonged decelerations upto 3 minutes with absence of accelerations.

Abnormal features: includes a CTG with baseline < 100 bpm, >180 bpm or Sinusoidal pattern for > 10 minutes, variability <5 bpm for 90 minutes, atypical variable decelerations, late decelerations or single prolonged decelerations for > 3 minutes.

FHR pattern classification
The NICHD workgroup in 2008 proposed terminology of a three-tiered system to replace the older undefined terms "reassuring" and "no reassuring".

Category I (Normal): Tracings with all these findings present are strongly predictive of normal fetal acid-base status at the time of observation and the fetus can be followed in a standard manner:
Baseline rate 110-160 bpm,
Moderate variability,
Absence of late, or variable decelerations,
Early decelerations and accelerations may or may not be present.

Category II (Indeterminate): Tracing is not predictive of abnormal fetal acid-base status, but evaluation and continued surveillance and reevaluations are indicated. Bradycardia with normal baseline variability. Tachycardia. Minimal or Marked baseline variability of FHR.

Accelerations: Absence of induced accelerations after fetal stimulation. Periodic or Episodic decelerations: Longer than 2 min but shorter than 10min; Recurrent late decelerations with moderate baseline variability. Variable decelerations with other characteristics such as slow return to baseline, overshoots of "shoulders" seen (humps on either side of deceleration).

Category III (Abnormal): Tracing is predictive of abnormal fetal acid-base status at the time of observation; this requires prompt evaluation and management. Absence of baseline variability with recurrent late or variable decelerations or bradycardia or Sinusoidal fetal heart rate. APGAR score at 1 minute and 5 minutes were noted. All neonatal intensive care unit admissions were reviewed and followed up till discharge.

Results

Table 1: Type of CTG abnormality (Niched)

Type of CTG abnormality (niched)	No. of patients
Cat ii	66
Cat iii	34

Among 100 cases 66(66%) of patients belong to caterogy ii and 34(34%) of patients belong to caterogy iii.

Table 2: Comparison of various ctg abnormalities with type of delivery

Type of CTG	Vaginal delivery	Instrumental delivery	Caesarean delivery	Total
Non-reassuring	19(39.58%)	10(20.83%)	19(39.58%)	48
Abnormal	8(15.83%)	8(15.83%)	36(69.23%)	52

Among 48 cases with non-reassuring CTG, 19 cases (39.58%) were delivered by Caesarean section, 19 (39.58%) were delivered by vaginal delivery and 10 (20.83%) were instrumentally delivered.

Among 52 cases with Abnormal CTG, 36 cases (69.23%) were delivered by Caesarean section, 8 (15.83%) were delivered by vaginal delivery and 8 (15.38%) were instrumentally delivered.

Table 3: Correlation of CTG Abnormality (Nice) With Apgar at 1 Min

	Type Of CTG (Nice)	
Apgar at 1 min	Non-reassuring	Abnormal
<7	14 (29.16%)	21 (40.38%)
>7	34 (72.19%)	31 (59.61%)
TOTAL	48 (100%)	52 (100%)

In 100 cases 48 patients had NON REASSURING CTG pattern.
Among them 14 (29.16%) patients had 1 min APGAR score <7 and 34 (72.19%) patients had 1 min APGAR score >7.
52 patients had Abnormal CTG pattern among them 21 (40.38%) patients had 1 min APGAR score < 7 and 31(59.61%) patients had 1 min APGAR score >7

Table no. 4: correlation of CTG abnormality (NICHD) with Apgar at 1 min

Apgar At 1 Min	CAT II	CAT III
<7	17	18
>7	49	16
TOTAL	66	34

Among 66 patients of CAT II 17 patients has Apgar score <7 at 1 minute and among 34 patients of CAT III 18 Patients had Apgar score < 7 at 1 minute.

Table 5: Correlation of CTG abnormality (nice) with Apgar at 5 min

	Type of CTG (nice)	
Apgar at 5 min	Non-reassuring	Abnormal
<7	04 (8.3%)	12 (23.07%)
>7	44 (91.6%)	40 (80.76%)
Total	48 (100%)	52 (100%)

Among 48 patients with NON REASSURING CTG pattern 04 (8.03%) patients had Apgar score <7 at 5 minutes and among 52 patients with Abnormal CTG pattern 12 (23.07%) patients had Apgar score < 7 at 5 minutes.

Table 6: Corelation of ctg abnormality (NICHD) with apgar at 5 min

Apgar at 5 min	Cat 2	Cat 3
<7	7	9
>7	59	25
TOTAL	66	34

Among 66 patients with category ii Apgar score was <7 in 7 cases and > 7 in 59 cases. And among 34 patients with category iii Apgar score was < 7 in 9 cases and >7 in 25 cases.

Table 7: Correlational Fhr Pattern with NICU Admission and Natal Deaths

Type of CTG	Nicu admissions	Neonatal death
Non-reassuring	13 (27.08%)	3 (6.25%)
Abnormal	18 34. 6%)	12 (23.07%)

Among 48 patients with non-reassuring CTG pattern 13 (27.08%) patient babies required nicu admission and 3 (6.25%) had neonatal deaths among 52 patients with abnormal CTG pattern 18(34.6%) patient babies required Nicu admission and 12(23.07%) had neonatal deaths.

Table 8: Association between Different Features of CTG with Apgar < 7 at 1 Min and < 7 at 5 Min, Nicu Admissions and Neonatal Deaths

	No of cases with Apgar < 7 at 1 min	No of cases with Apgar < 7 at 5 min	Nicu admissions	Neonatal death
Baseline FHR				
A. normal	11(37.9%)	04(14.2%)	11(35.48%)	05 (33.33%)
B. tachycardia	07(24.1%)	06(21.4%)	07(22.58%)	05 (33.33%)
C. bradycardia	11(37.9%)	08(28.5%)	13(41.93%)	05 (33.33%)
Variablity				
A. absent	10(34.4%)	08(44.4%)	11 (35.48%)	09 (60%)
B. minimal	08(27.58%)	05(27.7%)	10(32.25%)	01 (6.66%)
C. moderate	11(37.93%)	05(27.7%)	10(32.25%)	05 (33.33%)
D. marked	00	00	00	00

Acceleration				
Present	18(62.0%)	13(72.2%)	19(61.29%)	11 73.3%)
B. Absent	11(37.9%)	05(27.77%)	12(38.7%)	04 (26.66%)
A. Deceleration				
Absent	5(17.24%)	3(16.66%)	05 (16.1%)	03 (20%)
Present				
A. early	3(10.34%)	1(5.55%)	03 (9.67%)	03 (20%)
B. late	11(37.93%)	6(33.3%)	10 (32.25%)	06 (40%)
C. variable	9(31.03%)	7(38.8%)	12 (38.7%)	03 (20%)
D. prolonged	1(3.44%)	1(5.55%)	01 (3.22%)	00

In our study among Baseline FHR recording 36% had normal base line FHR and 64% had abnormal (Tachycardia & Bradycardia). Among 32 Neonates with low APGAR (<7) at one min, 62% had abnormal baseline FHR. Among 16 neonates with low APGAR (<7) at 5 min, 49.9% had abnormal base line FHR. Among 31 neonates required NICU admissions 64.4% had abnormal baseline FHR and among 15 neonatal deaths 66.6% had abnormal baseline FHR.

Among Baseline FHR VARIABILITY 40% had good base line variability and 60% had poor baseline variability (0-5 beats per minute). Among 32 Neonates with low APGAR (<7) at one min, 61.9% had poor baseline variability. Among 16 neonates with low APGAR (<7) at 5 min, 68.1% had poor baseline variability. Among 31 neonates required NICU admissions 67.6% had poor baseline variability and among 15 neonatal deaths 66.6% had poor baseline variability.

Among all Abnormal CTG parameters Absent base line variability, late, variable and prolonged deceleration patterns showed consistent association with low APGAR scores, Need of NICU stay and Neonatal deaths.

Discussion
Effect of CTG on cesarean section rates
In a study at Ain Shams University Maternity Hospita, 100 pregnant females, were studied. Fetal monitoring using cardiotocography is associated with a considerable false positive results and subsequent surgical intervention that might have not been necessary. Out of 100% of pathological or suspected pathological cardiotocograms, only 34% were valid (i.e., the infants were hypoxic after birth). The remaining 66% of infants, although their CTG findings were suggestive of fetal hypoxia, were born healthy and CS was probably not necessary. Thus, using of fetal heart rate abnormalities alone as a measure of diagnosis of fetal distress during labour is a contributing factor of increasing rate of cesarean sections [5].

The present study showed high number of false positive results. Out of 100% CTG abnormalities only 31% were valid (Neonates requiring NICU admission).In remaining 69% of neonates although their CTG findings are suggestive of fetal distress and hypoxia, were born healthy. Results regarding false positive rates and cesarean section rates were comparable to that of Cochrane study and also the above mentioned study.

Type of CTG abnormality and its relation to fetal outcome
In a study by neeru malik et al, Late decelerations showed worst prognosis with 2 perinatal deaths; variable decelerations were the next common CTG pattern and there were 3 NICU admissions for fetal asphyxia [8]

In a study by Shamci Abbasalizadeh regarding Correlation between no reassuring patterns in cardiotocography and birth asphyxia published in International Journal of Women's Health and Reproduction Sciences, there was a significant relationship between baseline FHR variability and fetal asphyxia. Birth asphyxia existed in 10 newborns; in all cases mild hypoxic ischemic encephalopathy (HIE) was observed. Within the no reassuring 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. In periodic or episodic decelerations, most asphyxia cases occurred in recurrent late decelerations with normal baseline variability and variable decelerations with shoulders or overshoots. With regard to the findings of the present study we can use no reassuring cardiotocography patterns, especially absent and minimal baseline FHR variability and periodic or episodic decelerations in prediction of birth asphyxia [6, 7].

In our present study results are comparable to the above study with Late decelerations showing worst prognosis with 6 neonatal deaths and 10 NICU admissions; bradycardia being the next common with 5 neonatal deaths and 13 NICU admissions.

Table 9: Type of CTG abnormality and its relation to fetal outcome

Type of CTG abnormality	NICU admissions	Neonatal Deaths
Bradycardia(n=30)	13	5
Tachycardia (n=32)	7	5
Late decelerations(n=22)	10	6
Variable decelerations(n=32)	12	3
Prolonged decelerations(n=6)	1	0

Predictive accuracy of Apgar scores in predicting fetal outcome
In a study by Kevin Jenniskens et al, on newborn outcomes after caesarean section for non-reassuring fetal status at University of British Columbia the following results were obtained APGAR score at one minute < 7 had the greatest predictive accuracy for the composite outcome (81% for both sensitivity and specificity) [9].

In our study Apgar at one minute and 5 minutes was taken into consideration as a measure for fetal outcome, which is said to have greatest predictive accuracy strengthening the study. Regarding the cesarean sections done for CTG abnormality the rates were comparable to the above study. The prevalence of abnormal Apgar scores at five minutes among neonates delivered by cesarean section for CTG abnormality is 10.9%. NICU admissions in patients delivered by cesarean section for CTG abnormality was 9

(16.36%). Thus, using of fetal heart rate abnormalities alone as a measure of diagnosis of fetal distress during labour is a contributing factor of increasing rate of cesarean sections.

Although more advanced methods like fetal scalp blood sampling to detect fetal acidosis and thus the risk of birth asphyxia, due to high cost of the procedure and non-availability in government hospital where the study is being done, continuous CTG monitoring was used to predict the fetal risk and neonatal outcome.

Summary

1. Among the 100 patients 48 cases (48%) showed non-reassuring and 52 cases (52%) showed abnormal FHR patterns.
2. Variable decelerations were commonest abnormal CTG patterns and seen in 32% of cases, next common was tachycardia in 32%, late deceleration in 22%, bradycardia in 30%.
3. 27 cases delivered vaginally, among them 19 cases were in the non- reassuring and 8 cases belongs to abnormal FHR group.
4. Operative interventions were done in 73 (73%) of cases. Among them cesarean deliveries were done in 55 (55%) cases and 18 (18%) cases had instrumental deliveries.
5. Apgar score < 7 at 1 min (depressed) was 29.16% and 40.38%% in non- reassuring and abnormal groups respectively.
6. Apgar score at 5 minutes were 7% and 12% in non-reassuring and abnormal groups respectively.
7. Admission to NICU were 13% and 18% in non-reassuring and abnormal FHR groups respectively and.
8. 15 Perinatal deaths occurred, 4 in cesarean section group and 4 in instrumental vaginal deliveries and 7 in vaginal delivery group.

Conclusion

In the results of the study of non-reassuring and abnormal patterns of CTG, the parameters especially FHR baseline variability, bradycardia, late and variable deceleration are associated with poor fetal outcome independently and can be used in the prediction of cases associated with birth asphyxia.

In spite of increased operative delivery there was decreased rate of NICU admissions and neonatal deaths providing that early intervention and resuscitation will improve neonatal outcome.

Here by I conclude that Continuous EFM should be offered and recommended for high-risk pregnancies where there is an increased risk of perinatal deaths.

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