Original Article

Efficacy of Admission Cardiotocography in Early Stage of Labour in Predicting Perinatal Outcome among Parturients in a Tertiary Health Facility in Ogun State, Southwest Nigeria

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Abstracts

Background: Some fetuses will present with hypoxia at admission into the labour room and may not be able to withstand the stress of frequent and adequate uterine contractions. Admission cardiotocography (CTG) in early labour has been thought to be useful in detecting babies with such conditions therefore affording the obstetrician early intervention to prevent adverse perinatal outcome. **Aim:** This study aims to determine the predictive value of admission cardiotocogram in early labour in the early detection of fetal hypoxia and its adverse perinatal outcome. **Patients, Materials and Methods:** It was a prospective cross-sectional study among low- and high-risk pregnant women in a tertiary health institution in Abeokuta, Southwest Nigeria. Two hundred participants with singleton fetus in cephalic presentation were recruited consecutively at term in early first stage of labour and were subjected to 20 min admission CTG (ACTG). The resulting cardiotocograms were classified into reactive, suspicious or pathological and further management was based on the cardiotocogram findings. Perinatal outcomes were assessed and statistical analysis done using IBM SPSS version 20. The main outcome measures were mode of delivery and perinatal outcome using Apgar scores, neonatal pulse oximetry, and neonatal unit (NNU) admission. **Results:** Seventy percent of the participants were multipara, 42% were aged between 26 and 30 years. Suspicious and pathological CTGs were 9% and 1%, respectively. Operative delivery, birth asphyxia, and NNU admission of babies were more common among the non-reactive (suspicious/pathological) CTG groups compared to reactive CTG group. The test, in predicting perinatal asphyxia, has low sensitivity (42.86%) and positive predictive values (15%) but high specificity (91.19%) and negative predictive values (97.78) **Conclusion:** ACTG is a simple, noninvasive screening tool in labour. It is highly effective in predicting fetuses unlikely to develop birth asphyxia but not so effective at predicting those likely to develop asphyxia. The test should be used with caution.

Keywords: Admission cardiotocograph, efficacy, labour, perinatal outcomes

Introduction

Intrapartum fetal monitoring used in assessing fetal well-being during labour and delivery process is a central component of intrapartum care for decades.[1] Over the years, electronic fetal monitoring including cardiotocography (CTG) has become the most common means of fetal heart rate (FHR) monitoring both during antenatal and intrapartum.[1] The importance of CTG recordings is to identify when there are deviations from normal in fetal well-being to allow prompt interventions before the fetus is harmed.[2] The vast majority of the fetuses with an adequate uteroplacental reserve will cope well during labour while acute or subacute hypoxia may develop in those with uteroplacental insufficiency. Some level of hypoxia may be present in some fetuses even prior to the onset of labour while majority of hypoxia will develop in labour. Proper monitoring during labour will identify those at risk and will

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guide towards prompt intervention to avert brain damage such as hypoxic-ischemic encephalopathy and other long term sequelae like cerebral palsy.[3]

Admission CTG (ACTG) is a 20–30 min tracing of the FHR and uterine activity on admission into labour room at the onset of labour. It is non-invasive and serves as a screening test in the detection of babies who suffer hypoxia either prior to onset of labour or early in labour. Early detection of fetal hypoxia will assist the obstetrician in determining the appropriate intervention to be offered to prevent untoward perinatal outcome.

Many guidelines recommended the use of intermittent auscultation in labour using either the hand-held Doppler ultrasound or Pinnard.[4-6] In busy labour rooms with dearth of personnel to appropriately and adequately monitor labour as seen in many developing countries such as Nigeria, this recommendation has been difficult to be strictly adhered to, leading to high perinatal morbidity and mortality. As of 2015, Nigeria had a neonatal mortality rate of 34/1000 live births.[7] With birth asphyxia constituting 30.9% of the causes making it the second most common cause after prematurity which constituted 31.1%.[7] Most of these asphyxia could have been prevented with early detection of fetal hypoxia in labour. It, therefore, becomes imperative to find a means of detecting fetal distress/hypoxia early in labour for prompt attention to reduce perinatal asphyxia. Performing a routine ACTG on all parturients at admission into the labour rooms, before continuation of intermittent auscultation for those with reactive CTGs, may help in isolating those at risk of hypoxia and hence giving them more special attention.

Despite several studies reporting the usefulness of the ACTG test in predicting fetal distress/hypoxia early in labour, some reported otherwise while some also reported increase in unnecessary intervention with its use.[8-13] With no consensus yet in its use, it is important we carry out similar studies in our environment to evaluate its value in early diagnosis of fetal hypoxia and predicting perinatal outcomes. The findings in the study will help in formulating protocols on its use or otherwise both in our obstetric unit locally and nationally in future.

Patients, Materials and Methods

Study design

It was a prospective cross-sectional study carried out between January 2017 and June 2017.

Study population

The study population was made up of both low- and high-risk (without segregating them to avoid bias) pregnant women with singleton fetus and cephalic presentation admitted into the labour room in early first stage of labour in our facility during the study period and met the inclusion criteria.

Inclusion/exclusion criteria

All low- and high-risk pregnant women with singleton fetus in a longitudinal lie and cephalic presentation at an estimated gestational age of 37–41 weeks who presented in the spontaneous first stage of labour were included in the study. Women with any contra-indication to vaginal delivery or situation that would not allow labour to continue such as abruptio placentae and cord prolapse were excluded. Also excluded were women carrying fetuses with intrauterine fetal death or congenital anomalies confirmed by ultrasound scan, and women already booked for elective caesarean section.

Data collection

Two hundred women who met the inclusion criteria and consented to the study were recruited consecutively and written consent obtained from them. Information regarding their biodata and obstetric history were gotten from them and properly filled into a pro forma. General physical examination, abdominal and vaginal examination findings were also recorded. The participants were subjected to ACTG for 20 min with the patient in right or left lateral position. The FHR tracings obtained were categorized as reactive (normal), equivocal (suspicious) or ominous (pathological) according to the classification proposed by National Institute of Clinical Excellence – Clinical guideline September 2007.[14]

The ACTG recording of FHR and uterine contractions were done by using the Huntleigh Health Care BD4000XS fetal monitor manufactured by Huntleigh diagnostic limited Cardiff, Wales.

Parturients with reactive tracing were monitored intermittently by auscultation for 60 s every 30 min in the first stage of labour and every 5 min in the second stage of labour post contraction using a handheld Huntleigh Doppler or Pinnard. The readings were transferred to their partographs. Cases with equivocal or ominous tracings had intra-uterine resuscitation and were put on continuous CTG monitoring. If despite the intrauterine resuscitation, there was persistent appearance of late, significant variable or prolonged decelerations, delivery was hastened by operative or instrumental intervention depending on the stage of labour. After delivery, the Apgar scores and pulse oximetry were determined by the paediatrician in attendance. An Apgar score of 7 or more at 5 min was adjudged to be free of asphyxia. Pulse oximetry was taken using the Ohmeda Tuffsat handheld oximeter, manufactured by GE healthcare. It has a rubber grip wrap sensor which is placed on the finger for spot check of oxygen saturation in percentage. In addition, it has a backlit liquid crystal displays screen and uses 4 AAA batteries. The neonates admitted to neonatal unit (NNU) were managed by the Neonatologist and pediatric residents in neonatology posting. They were observed and monitored for neonatal seizures for up to 48 h, while those being nursed by the mother side were observed and monitored in the post natal ward.

Foetuses were considered to be in distress if there were two or more of the following; FHR of 100–109 or 161–180 bpm, baseline variability <5 bpm, atypical variable deceleration, late deceleration, single prolonged deceleration >3 min, absence of acceleration.

Perinatal asphyxia was assessed if there was the presence of one or more of; Apgar score of <7 at 5 min, admission into NNU for birth asphyxia, neonatal seizure within 24–48 h excluding metabolic causes, intrapartum fetal death.

Data analysis

Information obtained from the participants were retrieved from the pro forma, cardiotocogram, partograph and neonatal admission files. The information were coded and filled into a spreadsheet and analyzed using IBM SPSS package version 20 (Statistical Package for Social Sciences (SPSS) version 20 for Windows manufactured by International Business Machine (IBM) Corporation, Armonk, New York, USA). Data were presented in frequency tables and inferential analysis done using Spearman correlation along with student *t*-test for continuous variables while Chi-square was used for categorical variables. The level of statistical significance was taken as $P < 0.05$.

Ethical consideration

Ethical permission to carry out the study was sought and approval obtained from the Hospital's Health Research Ethics Committee.

Results

Two hundred pregnant women who met the inclusion criteria were recruited in the study. Only two of the women were unbooked while others were booked. The mean gestational age was 39.09 (±1.04) weeks with a range of 37–41 weeks.

Table 1 shows the age distribution of the women. The mean age of the participants was 30.12 (±4.55) years while 42.0% of them fell in the age group 26–30 years. Table 2 shows the parity of the women. Majority (66.5%) of the women were para 2 to 4.

The incidence of pathological ACTG was 1% (2 cases), suspicious was 9% (18 cases), and reactive ACTG findings were 90% (180 cases). All foetuses with the suspicious and pathological ACTGs had intrauterine resuscitation. Among the 18 suspicious ACTGs, 13 (72.2%) reverted to reactive CTGs and labour was allowed to continue while 5 either remained persistently suspicious or worsened. The two pathological ACTGs remained pathological despite intra-uterine resuscitation.

Table 3 shows the relationship between the ACTG findings and mode of delivery. Among the women, 158 (79%) had a spontaneous vaginal delivery, 42 (21%) had operative deliveries of which 33 (78.6%) of the 42 were emergency caesarean section (EMCS) putting the prevalence of EMCS at 16.5%. The remaining 9 (21.4%) of the 42 operative deliveries were vacuum deliveries putting the overall incidence at 4.5%. None had forceps delivery. Suspected fetal distress was responsible for 7 (21.2%) of the EMCS. All the caesarean sections were performed under spinal anesthesia. Thirty-two (17.78%) of the reactive CTG group had operative deliveries with fetal distress as an indication accounting for just one of the cases. Eight (44.44%) of all the suspicious CTG groups had operative deliveries; four for fetal distress and four for other indications. The two (100%) mothers in the pathological CTG group also had operative deliveries for foetal distress. Categorizing the suspicious and pathological CTG together as non-reactive CTG group, there was a statistically significant difference in the mode of delivery between the reactive and non-reactive groups as shown in Table 3 ($\chi^2 = 11.265$, $P = 0.002$)

Table 4 shows the Apgar scores of the newborns, One hundred and eighty-seven (93.5%) babies had Apgar scores ≥7 at 1 min and the number of babies with Apgar scores of ≥7 increased to 193 (96.5%) at 5 min. The average Apgar scores at 1 and 5 min were 7.90 ± 1.11 and 9.18 ± 0.84, respectively.

Table 5 shows the association between ACTG categories and perinatal outcomes. Birth asphyxia was diagnosed in 7 (3.5%) of the neonates; four (2%) from the reactive CTG group and two (1%) from the suspicious group and 1 (0.5%) from the pathological CTG group. This represented an asphyxia prevalence of 2.2% within the reactive CTG group, 11.11% within the suspicious group and 50% within the pathological group. Only one fetal distress was diagnosed in the normal CTG group but 4 babies had asphyxia. Of the four cases

Table 1: Age distribution of the women

Age (years)	Frequency (*n*=200), *n* (%)
≤20	3 (1.5)
21-25	31 (15.5)
26-30	84 (42.0)
31-35	56 (28.0)
36-40	25 (12.5)
>40	1 (0.5)
Age (years), mean±SD	30.12±4.55

SD: Standard deviation

Table 2: Parity of the women

Parity	Frequency (*n*=200), *n* (%)
0-1	59 (29.5)
2-4	133 (66.5)
≥5	8 (4)
Mean parity	2.25±1.16

Table 3: Association between admission cardiotocographic findings and mode of delivery

CTG categories	Mode of delivery (*n*=200), *n* (%)			χ^2	*P*
	SVD	Operative delivery	Total		
Reactive	148 (74)	32 (16)	180 (90)		
Nonreactive	10 (5)	10 (5)	20 (10)		
Total	158 (79)	42 (21)	200 (100)	11.265	0.002

CTG: Cardiotocography, SVD: Spontaneous vaginal deliveries

diagnosed with fetal distress in the suspicious group, only two (50%) had asphyxia at delivery while One (50%) of the two fetal distress diagnoses in the pathological group had birth asphyxia. Categorizing both the suspicious and pathological CTG as nonreactive CTG and defining birth asphyxia as Apgar score of <7 at 5 min, the study showed that there was statistically significant difference in the development of asphyxia between the reactive and non-reactive CTG groups ($\chi^2 = 8.7014$, $P = 0.023$).

Eight (4%) of the neonates were admitted into the NNU; five (2.5%) were from the reactive ACTG group, two (1%) from the suspicious group and 1 (0.5%) from the pathological group. The admission rate within the individual groups was 2.78% for the reactive CTG, 11.11% for suspicious group and 50% for the pathological group. Still categorizing the suspicious and pathological CTGs together as non-reactive group, the study showed that there was statistically significant difference in the neonatal admission rate between the reactive and non-reactive ACTG groups ($\chi^2 = 7.002$, $P = 0.035$), as shown in Table 5. There were no cases of neonatal seizures or perinatal deaths among the neonates admitted for birth asphyxia.

Table 6 shows the association between the ACTG and oxygen saturation. The mean oxygen saturation of the reactive ACTG group was less than the non-reactive ACTG group (93.45 ± 1.19% vs. 94.34 ± 0.92%). There was no statistically significant difference in the oxygen saturation between the two groups ($t = 0.44$, $P = 0.344$).

Tables 7a and b and 8a and b show the values of ACTG and diagnostic parameters in predicting neonatal asphyxia and admission to the NNU.

Table 4: Apgar scores of the newborns

Fetal outcome	Frequency (n=200), n (%)
Apgar score at 1 min	
<7	13 (6.5)
7 and above	187 (93.5)
Mean score±SD	7.90±1.11 (100)
Apgar score at 5 min	
<7	7 (3.5)
7 and above	193 (96.5)
Mean score±SD	9.18±0.84 (100)

SD: Standard deviation

Table 5: Association between admission cardiotocography categories and perinatal outcome

CTG category	Perinatal outcome (n=200), n (%)			χ^2	P
	Birth asphyxia				
	Yes	No	Total		
Reactive	4 (2)	176 (88)	180 (90)		
Nonreactive	3 (1.5)	17 (8.5)	20 (10)		
Total	7 (3.5)	193 (96.5)	200 (100)	8.7014	0.023
CTG category	**NNU admission**			**χ^2**	**P**
	Yes	No	Total		
Reactive	5 (2.5)	175 (87.5)	180 (90)		
Nonreactive	3 (1.5)	17 (8.5)	20 (10)		
Total	8 (4.0)	192 (96)	200 (100)	7.002	0.035

CTG: Cardiotocography, NNU: Neonates admitted to neonatal unit

Table 6: Association between admission cardiotocography categories and pulse oximetry of the babies at delivery

ACTG findings	Pulse oximetry, mean±SD	t-test	P
Reactive (n=180)	93.45±1.19		
Nonreactive (n=20)	94.34±0.92		
Total (n=200)		0.400	0.344

ACTG: Admission cardiotocography, SD: Standard deviation

Table 7a: The value of admission cardiotocography in predicting neonatal asphyxia

ACTG categories	Perinatal outcomes (n=200), n (%)		
	Asphyxia		
	Yes	No	Total
Reactive	4 (2)	176 (88)	180 (90)
Nonreactive	3 (1.5)	17 (8.5)	20 (10)
Total	7 (3.5)	193 (96.5)	200 (100)

Sensitivity=3/7×100=42.86% Specificity=176/193×100=91.19% Accuracy= (3+176)/200×100=89.5% PPV=3/20×100=15% NPV=176/180×100=97.78%. ACTG: Admission cardiotocography, PPV: Positive predictive value, NPV: Negative predictive value

Table 7b: Diagnostic parameters of admission cardiotocography in predicting neonatal asphyxia

Diagnostic parameter	Percentage (%)
Sensitivity	42.86
Specificity	91.19
PPV	15
NPV	97.78
False negative	2
False positive	8.5
Accuracy	89.5

PPV: Positive predictive value, NPV: Negative predictive value

Table 8a: The value of admission cardiotocography in predicting neonates admitted into neonatal unit admission

ACTG categories	Perinatal outcomes (n=200), n (%)		
	Asphyxia		
	Yes	No	Total
Reactive	5 (2.5)	175 (87.5)	180 (90)
Nonreactive	3 (1.5)	17 (8.5)	20 (10)
Total	8 (3.5)	192 (96.5)	200 (100)

Sensitivity=3/8×100=37.5% Specificity=175/192×100=91.15% Accuracy=3+175/200×100=89.5% PPV=3/20×100=15% NPV=175/180×100=97.22%. ACTG: Admission cardiotocography, PPV: Positive predictive value, NPV: Negative predictive value

Table 8b: Diagnostic parameters of admission cardiotocography in predicting neonatal admission into neonatal unit

Diagnostic parameter	Percentage (%)
Sensitivity	37.5
Specificity	91.15
PPV	15
NPV	97.22
Accuracy	89.5

PPV: Positive predictive value, NPV: Negative predictive value

Discussion

The majority of the participants were multiparas and within the age range of 26–30 years. These demographic factors differ from the works by Rahman *et al*.,[9] Kumar and Jaju[15] Nagure *et al*.[16] and Imaralu *et al*.[12] where the majority of their subjects were nulliparas but similar to report by Kavitha and Madhavi[13] in which the majority of their subjects were multiparas. Unlike the studies by Nagure and Kumar which focused only on high-risk pregnancies, this present study involved both the low and high risks. This may partly explain the differences in parity as nulliparity is more associated with pregnancy complications like hypertensive disorders of pregnancy, anemia in pregnancy, post-dated pregnancy among others, thereby making such pregnancies high risk.

The prevalence of reactive ACTG of 90% in this study was higher than those reported in different studies by Bhartiya *et al*.,[8] Kavitha and Madhavi[13] Nity *et al*.[17] and Dwarakanath *et al*.[18] in India and Imaralu *et al*.[12] in the same Southwest Nigeria where this study was conducted, but similar to that reported by Rahman *et al*.[9] in Gangtok, India and another study by Rao *et al*.[19] The 9% prevalence of suspicious CTG in this study was similar to that reported by Rahman *et al*.,[9] slightly higher than the 3% reported by Rao,[19] but smaller than the prevalence reported by most of the other similar studies.[8,9,12,13,17,20] A prevalence of 1% pathological ACTG in this study was smaller than all the comparative studies that were reviewed.[8,9,12,13,17,20] This difference may be attributed to the differences in the study population in the different studies as some of the studies focused only on high-risk pregnancies and some also included preterm labour which was excluded from our study.

Unlike the study by Bhartiya where majority (62%) of the women were delivered through caesarean section,[8] vaginal delivery accounted for a higher proportion in this study and some other similar studies.[17,18] Among those who had operative deliveries in this study, caesarean section accounted for a higher proportion. The operative deliveries were least common among the reactive group (17.77%), more commonly performed among the suspicious group (44.44%), and most common among the pathological group (100%). This follows the pattern in all other similar studies where the highest operative delivery rates were reported among the pathological groups followed by the suspicious group and lowest in the reactive ACTG groups.[9,13,15,17-20] The higher incidence of operative delivery among the nonreactive group was expected as many of the fetuses in those groups who did not respond well to intrauterine resuscitation had their deliveries expedited by operative deliveries to prevent/reduce serious adverse perinatal outcome.

The proportion of neonates with Apgar score of <7 at 5 min/birth asphyxia was highest among the pathological group (50%), followed by the suspicious group (11.11%) and least among the reactive group (2.2%) and there was statistically significant difference between the reactive and non-reactive ACTG groups. This was similar to reports by Rahman *et al*.,[9] Kumar and Jaju[15] Rao *et al*.,[19] Joshi *et al*.[20] and Nity *et al*.[17] in which there were also statistically significant differences between the reactive and non-reactive ACTG groups but different from work by Imaralu *et al*.[12] where they found that the Apgar score at 5 min was independent of the ACTG. The higher incidence of birth asphyxia demonstrated among the non-reactive group showed the ability of the ACTG test to truly predict some of the babies that actually developed the condition.

In this study, 15% of fetuses with either suspicious or pathological ACTG were admitted to the NNU compared to only 2.7% of fetuses with reactive ACTG and this showed a statistically significant difference between the 2 groups. This was similar to the study by Kumar and Jaju where neonatal intensive care unit (NICU) admission rate for babies with pathological ACTG was more than 5 times the admission rate for reactive ACTG.[15] NICU admission rate for equivocal and ominous ACTG was even much higher in the study by Nagure *et al*. where more than 57% of the ominous group were admitted.[16] Their studies however only focused on the high-risk pregnancies unlike in our own study that involved both low- and high-risk pregnancies. Findings in this study were however different from the study by Bhartiya *et al*. where they found no statistically significant difference in the ACTG and neonatal intensive care unit admission in both low- and high-risk mothers.[8] While Bhatiya compared the admission rate based on the risk of the pregnancy (high/low) we compared based on the ACTG categorization.

This present study evaluated hypoxemia in the newborns by measuring their pulse oximetry. It showed a slightly higher mean oxygen saturation in the non-reactive group compared to the reactive group but there was no statistically significant difference between the two groups. Nitty *et al*.[17] and Rahman *et al*.[9] in their studies used the cord pH level and found that pH <7 was significantly higher in the pathological groups.

The specificity and negative predictive values of 91.19% and 97.78% respectively in this study were similar to that reported in many other studies.[9,19,21] The sensitivity of ACTG in predicting neonatal asphyxia in our study was 42.86% which was higher than that reported by Rao *et al*.,[19] but smaller than a report from Nikita and Rahman *et al*.[21,9] The positive predictive values of 15% in this present study was less than the value quoted by other studies.[9,19,21] The ACTG has a similar diagnostic diameter in predicting admission to NNU as that of predicting neonatal asphyxia as shown in both Tables 7 and 8 respectively. The slight differences in these values compared to other studies may

be a result of the differences in the study population. Apart from that, the perinatal outcome parameters used in calculating the values in the different studies also differ. While fetal distress was used in some of the studies, we used birth asphyxia being the definite perinatal outcome as not all the cases of fetal distress had birth asphyxia or any other adverse perinatal outcome.

The high negative predictive values in this study demonstrated that ACTG is an effective tool in detecting babies who will unlikely develop birth asphyxia. Its shortcoming however is the low positive predictive value which means the test has low ability to predict the babies who will develop birth asphyxia when the ACTG is positive.

Limitations

Nonavailability of facility for fetal scalp sampling and blood gas analysis to make a definite diagnosis of fetal acidosis in labour and birth asphyxia after delivery, respectively. Another limitation was that the babies with asphyxia were not followed-up for long-term sequelae of birth asphyxia.

Conclusion

ACTG is a simple and non-invasive screening procedure for fetal asphyxia in labour. This study showed that it has low sensitivity and negative predictive values, but high specificity and positive predictive values in predicting babies that will develop birth asphyxia. It is therefore highly effective in predicting babies who are unlikely to develop birth asphyxia but not so effective in predicting babies who are likely to develop asphyxia. It also has the propensity of increasing operative intervention. Intrauterine resuscitation was found to shift suspicious CTGs to reactive type and thereby probably contributing to reduced cases of fetal distress and birth asphyxia. No neonatal seizures or mortality was recorded in the study.

Recommendation

It is recommended that ACTG should be deployed in early stage of labour but should be used with caution and should not replace the routine close fetal heart monitoring in labour. Fetuses of all mothers with suspicious CTGs should have intrauterine resuscitation and reassessed before any definitive intervention is instituted.

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Conflicts of interest

There are no conflicts of interest.

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