Association of Abnormal Cardiotocographic Patterns with Intraoperative Caesarean Section Findings and Neonatal Outcomes: A Hospital-Based Observational Study.

ABSTRACT

Background: Cardiotocography (CTG) is widely used for antepartum and intrapartum fetal surveillance. Abnormal fetal heart rate patterns may indicate fetal compromise and can influence the decision for operative delivery. Correlation of CTG abnormalities with intraoperative findings and neonatal outcomes may help assess their clinical relevance.

Objectives: To evaluate CTG characteristics among women undergoing caesarean section for abnormal cardiotocography and to determine their association with intraoperative findings and neonatal outcomes.

Materials and Methods: This hospital-based observational study was conducted in the Department of Obstetrics and Gynaecology, Pt. J.N.M. Medical College and Dr. B.R.A.M. Hospital, Raipur, Chhattisgarh, from March 2023 to February 2024. A total of 200 pregnant women undergoing caesarean section for abnormal cardiotocography were included according to predefined eligibility criteria. Maternal demographic and obstetric characteristics, CTG parameters at the time of decision for caesarean section, intraoperative findings, and neonatal outcomes were recorded. Associations between CTG parameters and maternal, obstetric, intraoperative, and neonatal variables were analysed. A p-value <0.05 was considered statistically significant.

Results: The mean maternal age was 25.19 ± 4.14 years, and 56.5% of women were primigravidae. The mean baseline fetal heart rate (FHR) was 108.92 ± 10.04 beats/minute. Beat-to-beat variability was normal in 59.0%, absent in 39.0%, and poor in 2.0%. Accelerations were absent in 99.5%. Two decelerations were recorded in 75.5%, and late decelerations predominated (69.5%). Intraoperatively, meconium-stained liquor was observed in 44.0%, blood-stained liquor in 3.0%, reduced or scanty liquor in 31.5%, absent liquor in 10.5%, placental abruption in 3.5%, and nuchal cord in 46 cases. Neonatal resuscitation was required in 21.0%, and 39.5% required NICU admission. Baseline FHR differed significantly according to uterine contractions (p=0.031), intraoperative liquor colour (p=0.022), 5-minute Apgar score (p=0.019), need for resuscitation (p<0.001), and NICU admission (p=0.001). Beat-to-beat variability was associated with placental condition (p=0.003). Number of decelerations was associated with placental condition (p=0.048) and nuchal cord loops (p=0.003); type of deceleration was associated with nuchal cord loops (p=0.010) and 5-minute Apgar score (p=0.031).

Conclusion: Specific CTG characteristics, particularly baseline FHR, beat-to-beat variability, and deceleration patterns, were significantly associated with selected intraoperative findings and neonatal outcomes. CTG should be interpreted with the overall clinical and obstetric context.

Keywords: Cardiotocography; fetal heart rate; deceleration; caesarean section; nuchal cord; placental abruption; neonatal outcome; NICU admission

INTRODUCTION

Preconception maternal health and appropriate fetal surveillance are important determinants of favourable pregnancy and neonatal outcomes. Cardiotocography is widely used for antepartum and intrapartum fetal surveillance and assists in the assessment of fetal well-being.

Abnormal fetal heart rate patterns may reflect fetal compromise. Assessment of baseline fetal heart rate, beat-to-beat variability, accelerations, and decelerations forms an important component of CTG interpretation. However, individual CTG abnormalities may have variable relationships with the underlying intrauterine condition and subsequent neonatal outcome. Therefore, correlation of abnormal CTG characteristics with findings observed during caesarean section and neonatal outcomes is clinically relevant.

Intraoperative findings such as meconium-stained or blood-stained liquor, reduced liquor volume, placental abruption, and nuchal cord may be associated with fetal compromise. Similarly, neonatal outcomes such as low Apgar score, requirement for resuscitation, NICU admission, and neonatal mortality provide clinically relevant measures of neonatal condition.

The present study was undertaken to evaluate CTG characteristics among women undergoing caesarean section for abnormal cardiotocography and to determine their association with intraoperative findings and neonatal outcomes.

AIM

To study abnormal cardiotocographic findings in relation to intraoperative findings at caesarean section and neonatal outcomes.

OBJECTIVES

1. To describe CTG characteristics at the time of decision for caesarean section.

2. To evaluate intraoperative findings among women undergoing caesarean section for abnormal cardiotocography.

3. To assess neonatal outcomes among babies delivered by caesarean section for abnormal cardiotocography.

4. To determine the association of CTG parameters with maternal and labour characteristics.

5. To determine the association of CTG parameters with intraoperative findings.

6. To determine the association of CTG parameters with neonatal outcomes.

MATERIALS AND METHODS

Study Design

Hospital-based observational study.

Study Duration

March 2023 to February 2024.

Study Centre

Department of Obstetrics and Gynaecology, Pt. J.N.M. Medical College and Dr. B.R.A.M. Hospital, Raipur, Chhattisgarh.

Study Population

Pregnant women undergoing caesarean section for abnormal cardiotocography during the study period.

Sample Size

The sample size was calculated using EZR software using the formula for a single proportion and confidence interval. Taking a Z value of 1.96 at a 95% confidence interval, an expected proportion of perinatal asphyxia of 0.145 among babies born to women with abnormal cardiotocography, and a desired precision of 5%, a sample size of 200 participants was considered adequate.

Inclusion Criterion

All women undergoing caesarean section for abnormal cardiotocography in the Department of Obstetrics and Gynaecology during the study period.

Exclusion Criteria

1. Women who did not consent to participate.
2. Fetuses with prenatally diagnosed congenital anomalies incompatible with life.
3. Gestational age <34 weeks.

Methodology

Pregnant women admitted to the labour room of Dr. B.R.A.M. Hospital, Raipur, were assessed for eligibility. Detailed antenatal history was obtained from antenatal records and hospital admission records. Antenatal clinic records were reviewed to identify pregnancy-related risk factors.

A detailed clinical examination was performed. Ultrasound findings regarding fetal growth parameters, amniotic fluid, and Doppler studies were reviewed. Eligible women were enrolled according to the inclusion and exclusion criteria after obtaining written informed consent.

CTG was recorded on admission, followed by subsequent fetal monitoring. When CTG findings became suspicious, resuscitative measures were undertaken. Women with persistent abnormal/non-reactive CTG findings who underwent caesarean section constituted the study population.

At the time of decision for caesarean section, CTG parameters including baseline FHR, beat-to-beat variability, accelerations, and decelerations were recorded. Intraoperative findings including uterine condition, colour and amount of liquor, placental condition, and nuchal cord were documented.

Neonatal outcomes included birth weight, Apgar score, need for resuscitation, NICU admission, indication and duration of NICU admission, complications during NICU stay, and final documented neonatal outcome.

Statistical Analysis

Descriptive variables were expressed as frequencies, percentages, means, and standard deviations, as appropriate. Comparisons of mean baseline FHR between two groups were performed using the t-test, while comparisons involving more than two groups were performed using analysis of variance. Correlation coefficients were calculated for continuous variables. Associations between categorical variables were assessed using the chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

Maternal and Obstetric Characteristics

A total of 200 women were included. The mean maternal age was 25.19 ± 4.14 years. The largest proportion were aged 20–25 years (49.5%), followed by 26–30 years (31.5%), <20 years (9.5%), 31–35 years (7.5%), and >35 years (2.0%). Most women were housewives (49.0%), followed by labourers (22.5%), farmers (20.0%), teachers (7.5%), and private employees (1.0%). Urban residents constituted 55.0%. Middle and low socioeconomic groups constituted 51.5% and 48.5%, respectively. The mean height was 150.68 ± 3.52 cm and mean weight was 59.31 ± 6.81 kg. Primigravidae constituted 56.5%. Previous caesarean section was present in 5.5%. The most frequent pregnancy complication was post-dated pregnancy (21.5%), followed by hypertensive disorders, oligohydramnios (13.0%), and PROM (11.5%). Fundal height corresponded to term size in 70.5%. Cephalic presentation was present in 98.5%. Uterine contractions were present in 43.0%. The mean FHR at admission was 122.66 ± 18.89 beats/minute. Clinically assessed liquor was adequate in 77.5%, borderline in 14.0%, and inadequate in 8.5%. The mean cervical dilatation was 2.52 ± 1.58 cm and mean cervical length was 1.83 ± 1.02 cm. Membranes were intact in 63.5% and ruptured in 26.0%.

CTG Characteristics

The mean baseline FHR was 108.92 ± 10.04 beats/minute. Beat-to-beat variability was normal in 59.0%, absent in 39.0%, and poor in 2.0%. Accelerations were absent in 199 cases (99.5%). Two

decelerations were recorded in 151 cases (75.5%), one in 41 (20.5%), and none in eight (4.0%). Late decelerations occurred in 139 cases (69.5%) and variable decelerations in 54 (27.0%).

Intraoperative Findings

The uterus was normal in 196 women (98.0%). Intraoperative liquor was clear in 100 cases (50.0%), meconium-stained in 88 (44.0%), blood-stained in six (3.0%), and not available in six (3.0%). Liquor was adequate in 115 cases (57.5%), excessive in one (0.5%), reduced in 19 (9.5%), scanty in 44 (22.0%), and absent in 21 (10.5%). Placental abruption was identified in seven women (3.5%). A nuchal cord was documented in 46 cases: double loop in 27 (58.7%), single loop in 18 (39.1%), and triple loop in one (2.2%).

Neonatal Outcomes

Of 200 neonates, 103 (51.5%) were male and 97 (48.5%) female. Mean birth weight was 2664.42 ± 553.31 g. Neonatal resuscitation was required in 42 cases (21.0%). NICU admission was required in 79 neonates (39.5%), and mean NICU stay was 2.09 ± 3.84 days. Among neonates with documented final NICU outcomes, 68 (94.4%) were discharged and four (5.6%) died.

Associations with Maternal and Labour Characteristics

Baseline FHR showed a weak negative correlation with maternal height ($r=-0.154$, $p=0.030$) and a positive correlation with FHR at admission ($r=0.359$, $p<0.001$). Baseline FHR differed significantly by maternal age ($p=0.041$), educational status ($p<0.001$), and presence of uterine contractions ($p=0.031$). The type of deceleration was significantly associated with clinically assessed liquor volume ($p=0.002$).

Associations with Intraoperative Findings

Mean baseline FHR differed significantly according to intraoperative liquor colour ($p=0.022$). Beat-to-beat variability was significantly associated with placental condition ($p=0.003$). Number of decelerations was significantly associated with placental condition ($p=0.048$) and nuchal cord loops ($p=0.003$). Type of deceleration was significantly associated with nuchal cord loops ($p=0.010$).

Associations with Neonatal Outcomes

Mean baseline FHR differed significantly according to 5-minute Apgar score ($p=0.019$), need for neonatal resuscitation ($p<0.001$), and NICU admission ($p=0.001$). Mean baseline FHR was 103.90 ± 8.23 beats/minute among neonates requiring resuscitation versus 110.25 ± 10.08 among those not requiring resuscitation. It was 105.92 ± 7.42 among NICU-admitted neonates versus 110.88 ± 11.03 among those not admitted. Type of deceleration was significantly associated with 5-minute Apgar score ($p=0.031$).

DISCUSSION

The present hospital-based observational study evaluated CTG characteristics, intraoperative findings, and neonatal outcomes among 200 women undergoing caesarean section for abnormal

cardiotocography. Selected CTG characteristics, particularly baseline FHR, beat-to-beat variability, and deceleration patterns, were significantly associated with specific intraoperative findings and selected neonatal outcomes.

The mean maternal age was 25.19 ± 4.14 years, comparable to studies by Chetandas et al. (2013), Rana et al. (2018), Gurung et al. (2019), Singh et al. (2022), and Kumari et al. (2023). Primigravidae constituted 56.5%, consistent with several previous studies cited in the thesis.

The most frequent antenatal complication was post-dated pregnancy (21.5%), followed by hypertensive disorders, oligohydramnios, and PROM. Ranjana et al. (2019) also reported post-dated pregnancy as the most frequent antenatal complication, while Singh et al. (2022) reported PROM in 11.4%, similar to the present 11.5%.

The mean baseline FHR was 108.92 ± 10.04 beats/minute, comparable to 106 beats/minute reported by Baruah et al. (2003), whereas Datta et al. (2019) and Kumari et al. (2023) reported approximately 140 beats/minute.

Normal beat-to-beat variability was present in 59.0%, while variability was absent in 39.0% and poor in 2.0%. Accelerations were absent in 99.5%. Late decelerations predominated (69.5%), whereas Datta et al. (2019) and Kumari et al. (2023) reported predominance of variable decelerations.

Meconium-stained liquor was the most frequent abnormal intraoperative liquor finding (44.0%). Comparable findings were reported by Behuria et al. (2016), Bhatia et al. (2018), Gurung et al. (2019), Datta et al. (2019), Ranjana et al. (2019), and Hussain et al. (2020).

A nuchal cord was documented in 46 cases, with double loops predominating. The number and type of decelerations were significantly associated with nuchal cord loops. Placental condition was significantly associated with beat-to-beat variability and number of decelerations.

Neonatal resuscitation was required in 21.0%, and NICU admission in 39.5%. Baseline FHR was significantly associated with 5-minute Apgar score, need for resuscitation, and NICU admission. Type of deceleration was also associated with 5-minute Apgar score.

However, CTG parameters were not significantly associated with all neonatal outcomes. No significant difference in baseline FHR was observed between neonates who died and those discharged. Individual CTG parameters therefore did not uniformly predict all neonatal outcomes.

Overall, specific CTG parameters were associated with clinically relevant intraoperative findings and selected adverse neonatal outcomes. Interpretation of the complete CTG pattern together with maternal, obstetric, and labour characteristics may provide greater clinical information than interpretation of an isolated parameter.

STRENGTHS AND LIMITATIONS

The study simultaneously evaluated detailed CTG characteristics, intraoperative findings, and neonatal outcomes in a defined population of women undergoing caesarean section for abnormal cardiotocography.

The study was single-centre and observational with 200 participants. The absence of a comparison group with normal CTG limited assessment of predictive performance and prevented conclusions regarding whether CTG increased or reduced unnecessary caesarean sections. Some subgroup analyses contained small numbers. Larger multicentre prospective studies with appropriate comparison groups are required.

CONCLUSION

Intrapartum cardiotocography is an important component of fetal surveillance. Specific CTG characteristics were significantly associated with selected intraoperative findings and neonatal outcomes among women undergoing caesarean section for abnormal cardiotocography.

Baseline FHR differed significantly according to intraoperative liquor colour and was associated with 5-minute Apgar score, need for neonatal resuscitation, and NICU admission. Placental condition was associated with beat-to-beat variability and number of decelerations. Number and type of decelerations were associated with nuchal cord loops, while type of deceleration was also associated with 5-minute Apgar score.

CTG findings should be interpreted in conjunction with the overall maternal, obstetric, and intrapartum clinical context rather than as an isolated determinant of operative delivery. Further multicentre studies with larger samples and appropriate comparison groups are required.