IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 21, Issue 2 Ser.12 (February. 2022), PP 52-69
www.iosrjournals.org

Role of Cardiotocography in Predicting Perinatal Outcome in High Risk Pregnancy

PUSHPAL CHOWDHURY
DHARMANAGAR DISTRICT HOSPITAL, NORTH TRIPURA

Date of Submission: 08-02-2022 Date of Acceptance: 22-02-2022

I. Introduction

Currently, the evaluation of fetal health is a very important concern, both for the obstetrician and the couple. It requires early recognition and prompt treatment of the foetal pathology in utero. The prevention and treatment of diseases in the mother were once the focus of obstetric practice, but today equal importance is given to the fetus. The fetal health in utero is evaluated in part by assessment of the fetal heart rate.[1]

The baby's heartbeat was first thought to be heard in utero in the middle of the seventeenth or eighteenth century, but it was not until the early nineteenth century that de Kergeradee suggested that listening to the baby's heartbeat might be clinically useful. The researcher proposed that it could be used to diagnose fetal life and multiple pregnancies, and wondered whether it would be possible to assess fetal compromise by detecting variations in fetal heart rate patterns. Since then various methods of listening to the fetal heart rate have been developed and introduced into maternity care with the aim of improving outcomes for babies and reducing the heartache for mothers and families when a baby dies or suffers from long term disability.[2]

Fetal heart rate monitoring is aimed at assessing fetal well being during pregnancy and labour. Although, vast majority of fetuses cope well during labour, the journey through the birth canal is stressful and fetuses mount a "stess response" during labour. Fetuses wih uteroplacental insufficiency develop hypoxia in labour that may be acute (developing over minutes) or subacute (developing gradually). Some fetuses may be even hypoxic prior to the onset of labour.. fetal monitoring during labour should identify the fetuses at risk of hypoxic organ damage, so that appropriate intervention could be instituted at the earliest to optimise perinatal outcome. Such an approach is likely to prevent neurological injury, including cerebral palsy. Indiscriminate use of electronic fetal heart rate monitoring in low-risk labour is known to increase operative interventions without any beneficial perinatal outcome.[3]

In developed countries, women comprising 85% of all live births undergo electronic fetal monitoring. Indeed, fetal monitoring has become the most prevalent obstetrical procedure in developed countries.[4]

The baby's heart rate can be monitored either intermittently (at regular intervals during labour) or continuously (recording baby's heartbeat throughout labour). Intermittent monitoring can be undertaken through a stethoscope or with a handheld ultrasound device. Alternatively, the baby's heart rate and the mother's uterine contractions can be recorded electronically on a paper trace known as cardiotocography(CTG). This is done by using a Doppler ultrasound transducer to monitor the baby's heart rate and a pressure transducer to monitor the uterine contractions. This is known as external CTG. An alternative means of monitoring the baby's heart rate with the CTG machine is to attach an electrode directly to the baby's presenting part usually the head. This form of continuous monitoring is known as " Internal CTG" and requires a ruptured amniotic sac and a scalp electrode attached tothe baby's head. Both forms of monitoring restrict the women's mobility during labour.

The term electronic fetal monitoring(EFM) is used synonymously with CTG monitoring, but is considered a less precise term because CTG monitoring also includes monitoring uterine contractions. Other methods of assessing the fetal health include fetal scalp blood sampling, vibroacoustic stimulation, fetal pulse oximetry, fetal electrocardiography, intrapartum Doppler velocitometry.[4]

In this study, the role of predicting perinatal outcome with the use of Cardiotocography in high risk pregnancy will be evaluated.

II. Review Of Literature

Holzmann M et al[5] conducted a prospective observational cohort study involving 1070 women at Karolinska university hospital, Stockholm, Sweden to identify Cardiotocography patterns associated with increased risk of intrapartum fetal acidaemia. Women with nonreassuring CTG pattern underwent fetal blood sampling (FBS) and lactate concentrations>4.8 mmol/l were defined as fetal acidaemia. A senior obstetrician

blinded to the lactate concentrations visually interpreted the CTG tracings. The workers concluded that late decelerations and severe variable decelerations increase the risk while a combination of these is associated with the highest risk of intrapartum fetal acidaemia.

Sharbaf FR et al[6] conducted a prospective study involving 818 intrapartum singleton pregnancies with gestational age>34 weeks in latent phase of labour with intact membranes to determine the value of normal and indeterminate patterns of cardiotocography in admission test and pregnancy outcome. Subjects were categorised as high risk and low risk groups and adverse pregnancy outcomes compared as regards hick meconium staining, low birth weight and NICU admissions. The workers concluded that indeterminate patterns of Cardiotocography can predict adverse pregnancy outcomes and when facing this condition, obstetricians should act cautiously.

Bogdanovic G et al[7] conducted a study in Clinic gor Gynaecology and Obstetrics UKC Tuzla and medical documentation from the history of mothers and newborns were used. Study group consisted of 68 pregnancies and newborns who developed HIE, control group consisted of 40 pregnancies, which resulted in birth of healthy newborns without signs of asphyxia. Pathological CTG records were found in 45(66.17) of the cases in study group in comparison to 11(27.5) in the control group. The investigators concluded that CTG is one of the reliable methods of fetal monitoring in pregnancy.

Alfirevic Z et al[2] conducted a systematic review of thirteen trials involving 37,000 women to evaluate the effectiveness of continuous Cardiotocography during labour. Randomised and quasi-randomised controlled trials involving a comparison of continuous cardiotocography with fetal monitoring, intermittent auscultation, and intermittent cardiotocography were selected. The workers concluded that continuous CTG during labour was associated with a reduction in neonatal seizures, but no significant difference in cerebral palsy or infant mortality rates were seen. However, continuous CTG was associated with an increase in caesarean sections and instrumental vaginal births.

Rahman H et al[8] conducted a study in Sikkim Manipal Institute of Medical Sciences (SMIMS), on 126 patients to determine the predictive value of admission CTG in predicting fetal hypoxia at the time of admission in labour and to correlate the perinatal outcome clinically. Admission CTG were reactive in 77%, equivocal in 14.4% and ominous in 8.7% women. Incidence of fetal distress, moderately thick meconium stained liquor, and NICU admissions were more in patients with ominous test results.

Devane D et al[9] conducted a systematic review to compare the effects of admission CTG with intermittent auscultation of the fetal heart rate on maternal and fetal outcome for pregnant women without risk factors on admission to labour ward. All randomised controlled trials involving term pregnant women considered to be at low risk for fetal hypoxia were included. The workers found no evidence of benefit for the use of the admission CTG for low-risk women on admission in labour. Furthermore, the probability is that admission CTG increases he caesarean section rate by approximately 20%. The findings of this review support recommendations that the admission CTG not be used for women who are at low risk on admission in labour.

Grivell RM et al[10] conducted a meta-analysis of six randomised control trials involving 2105 women to assess the effectiveness of antenatal CTG (both traditional and computerised) in improving outcomes for both mothers and babies during and after pregnancy. Comparison of computerised CTG versus traditional CTG showed a significant reduction in perinatal mortality. However, there was no significant difference identified in potentially preventable deaths. The workers concluded that there is no clear evidence that antenatal CTG improves perinatal outcome but addressed the need for further similar studies.

Kaban A et al[1] conducted a study to find out the success of fetal cardiotocography in predicting perinatal consequences. This study enrolled 101 full term pregnant women admitted for delivery in Vakif Gureba hospital in October 2009 to February 2010. The investigators concluded that cardiotocography is an important test during labour for management, but insufficient for predicting perinatal outcome (p value 0.53), hence the need for evaluation on an individual basis.

Resh P et al[11] conducted a study to find out the fetal distress already present on admission and to detect fetal outcome by admission CTG in order to avoid unnecessary delay in management. The study was conducted on 120 cases over a period of three years in a medical teaching hospital. Out of 120 patients, 99 were reactive, 18 were suspicious and 3 were ominous, sensitivity and specificity were both87.5%, positive predictive value was 98.98% and negative predictive value was 33.33%. The authors concluded that it was very reliable in predicting fetal compromise in labour.

Daly N et al[12] conducted a study to find out the obstetric and perinatal outcome in women presenting with decreased fetal movements in third trimester. It was a retrospective population based study for 1year on 524 women. Reassuring group comprised 482 women whereas nonreassuring group comprised 27 women who either underwent emergency delivery or comprehensive serial fetal assessment and had much higher rates of emergency caesarean sections and NICU admissions.

Sultana J et al[13] conducted a study for comparing normal and abnormal CTG patterns with pregnancy outcomes and early neonatal outcomes. For this fifty consecutive normal and abnormal CTG were collected within 1 hour before and after delivery with gestational age>= 32 weeks. Sensitivity of CTG was 87%,

specificity was 66%, positive predictive value was 54% and negative predictive value was 92% in predicting abnormal outcomes.

Hairong X et al[14] conducted a retrospective cohort study in patients with FHR tracing data (n=1638) from a peviously reported randomised controlled trial of amnioinfusion for the prevention of meconium aspiration syndrome to evaluate the association between specific fetal heart rate (FHR) patterns and adverse perinatal outcomes in labours that were complicated by thick meconium stained liquor. The workers concluded that specific abnormalities like prolonged decelerations, severe variable decelerations, bradycardia and tachycardia were associated with adverse perinatal outcomes.

Edwin C et al[3] observed continuous electronic fetal heart rate monitoring during labour is associated with a reduction in neonatal seizures, but no significant differences in cerebral palsy, infant mortality or other standard measures of neonatal well being. However, continuous cardiotocography was associated with an increase in caesarean sections and instrumental vaginal births. Recognition of abnormalities of the fetal heart rate as well as instituting timely and appropriate action, are both essential to improve the perinatal outcome.

Sheikh SM et al[15] conducted a study at Lady Dufferin Hospital in Karachi to determine the frequency of pathological pattern of CTG in antepartum and intrapartum period to evaluate the significance of those patterns. The study include 3,701 subjects out of which 60(1.62%) had pathological tracings of which 53 delivered live babies and remaining 7 were still births. APGAR score was <7 in 1 minute in 34(64.15%) while it was>7 at 1 minute in 19(35.84%). In this series, an increased frequency of detectable hypoxia on CTG was observed during the intrapartum period as compared to the antepartum period, however no significant association was found between a pathological CTG recording, fetal APGAR score and acidaemia.

Impey L et al[16] conducted a study at Dublin hospital involving 8580 women admitted to delivery ward to compare the effect on neonatal outcome of admission cardiotocography versus intermittent auscultation of the fetal heart rate. 44 (1·0%) women assigned admission cardiotocography did not undergo the procedure; 15 (0·4%) assigned usual care had admission cardiotocography. The primary endpoint occurred in 56 (1·3%) of 4298 women assigned admission cardiotocography and 55 (1·3%) of 4282 in the usual-care group (relative risk 1·01; 95% CI 0·70–1·47). Other indices of neonatal morbidity also showed no differences. Despite an increase in use of continuous cardiotocography (1·39; 1·33–1·45) and fetal blood sampling (1·30; 1·14–1·47) with admission cardiotocography, there were no significant differences in the rates of caesarean delivery (1·13; 0·92–1·40), instrumental delivery (1·03; 0·92–1·16), or episiotomy (1·06; 0·99–1·13). The researchers concluded that routine use of cardiotocography for 20 minutes on admission to the delivery ward does not improve neonatal outcome.

Odongo BE et al[17] conducted a prospective cohort study on 770 women presenting with labour in Aga Khan University Hospital, Nairobi to determine whether there are any differences in cardiotocography (CTG) tracings and perinatal outcomes in women with meconium stained liquour compared with those having clear liquour in labour. Initial and intrapartum CTG was done. Variable decelerations were the most common foetal heart rate patterns. In the initial CTG, suspicious (RR 1.033, 95% CI: 0.515 - 2.073), and pathologic (RR 1.490, 95% CI: 0.928-2.393) patterns were increased in the meconium stained group. In the intrapartum CTG, pathologic pattern was increased in women with meconium stain liquor (RR 1.096, 95% CI: 0.650-1.847). Apgar score of <7 was likely if the initial base line rate was abnormal (RR 1.357, 95% CI: 0.139 -1.009, irrespective of the state of liquor. Meconium staining of liquor was associated with Caesarean delivery (RR = 1.357, 95% CI: 1.010-1.823; P-value 0.042). There was no significant difference in the mean birth weights of the infants born to women in both groups (3359.72 grams and 3260.24 grams respectively, P = 0.282). One minute APGAR score in both groups was not significant (RR 0.390, 95% CI:0.131-1.1611). The researchers concluded that the suspicious and pathological tracings were increased in meconium stained group, with no significant difference in the APGAR scores in both groups..

Schilfrin BS[18] found that the evaluation of umbilical artery acidosis, low Apgar score and neonatal encephalopathy are limited in their ability to either include or exclude intrapartum injury. Proper evaluation of the CTG requires that trends and the rapidity of changes in patterns of decelerations are necessary to confidently define the normal-behaving fetus, the hypoxemic but uninjured fetus, the injured but non-hypoxic fetus, and finally to distinguish ischemic events from other forms of hypoxia. A newly defined CTG pattern, the 'conversion' pattern, appears to be a specific marker of ischemic injury and could help to redefine the role of CTG monitoring.

Murray DM et al[19] studied the fetal heart rate patterns of 35 infants who developed neonatal hypoxic-ischemic encephalopathy, with an aim to correlate those findings to the subsequent neurodevelopmental outcome.Timing of onset of pathological cardiotocographs (CTGs) was determined in each case by two blinded reviewers and related to EEG grade at birth and neurological outcome at 24 months. CTGs were available in 35 infants with HIE (17 mild, 12 moderate, 6 severe on EEG). Admission CTGs were normal in 24/35 (69%), suspicious in 8/35 (23%), and pathological in 3/35 (8%). All CTGs developed nonreassuring features prior to delivery. Three patterns of fetal heart rate abnormalities were seen: group 1, abnormal CTGs on admission in

11/35 (31%); group 2, normal CTGs on admission with gradual deterioration to pathological in 20/35 cases (57%); and group 3, normal CTGs on admission with acute sentinel events in 4/35 (11.5%). The median (interquartile range) duration between the development of pathological CTGs and delivery was 145 (81, 221) minutes in group 2 and 22 (12, 28) minutes in group 3. There was no correlation between duration of pathological CTG trace and grade of encephalopathy (R = 0.09, P = 0.63) or neurological outcome (P = 0.75). However, the grade of encephalopathy was significantly worse in group 3 (P = 0.001), with a trend to worse outcomes. The majority of infants with HIE have normal CTG traces on admission but develop pathological CTG patterns within hours of delivery. More severe encephalopathy was associated with normal admission CTG and acute sentinel events shortly before delivery.

Blix E[20] found that routine use of the cardiotocography as an admission test in low-risk women increases the incidence of minor obstetric interventions as well as caesarean sections, but has no impact on other important outcomes. The prognostic values are poor and the reliability varies from good to poor. The researcher found no evidence showing that the admission Cardiotocography as beneficial, and concludes that the test should not be offered to low risk women.

Gourounti K et al[21] conducted a meta-analysis of the randomised controlled trials and systematic reviews of randomised controlled trials. Studies were assessed for quality and outcome measured in terms of neonatal Apgar score at 5 mins after delivery, caesarean section and instrumental delivery. The pooled relative risk for having an Apgar score less than 7 points at 5 min after delivery was higher in the admission CTG group (RR 1.35, 95% CI 0.85-2.13) but it was not statistically significant. The pooled relative risks for having a caesarean section-delivery (RR 1.2 95% CI 1.00-1.41) and an instrumental delivery (RR 1.1 95% CI 1.00-1.18) were both higher in the admission CTG group. Both these were statistically significant. The researchers concluded that intrapartum admission cardiotocography in women at low obstetric risk increases the risk of caesarean section and instrumental delivery, with no evidence for neonatal benefit in terms of Apgar score at 5 minutes after delivery.

Salustiano EM et al[22] conducted a retrospective cohort and case control study of 27,252 term new borns in a low risk obstetric population between Januaty 2003 and December 2010. Maternal and infant databases were reviewed from all cases with Apgar score less than 7 at 5 mins of birth(n=121.0.4%) and 363 cases with Apgar score >7 at 5 mins of birth who were randomly selected by a computer programme. Outcomes were measured in terms of neonatal death, newborn respiratory distress, need for oro-tracheal intubation and neonatal intensive care unit(NICU) and hypoxic ischemic encephalopathy. After multiple regression analysis, repeated late decelerations on cardiotocography (OR: 2.4; 95% CI: 1.4-4.1) and prolonged second stage of labor (OR: 3.3; 95% CI: 1.3-8.3) were associated with AS5min < 7, as well as neonatal respiratory distress (OR: 3.0; 95% CI: 1.3-6.9), orotracheal intubation (OR: 2.5; 95% CI: 1.2-4.8), need for NICU (OR: 9.5; 95% CI: 6.7-16.8), and hypoxic-ischemic-encephalopathy (OR: 14.1; 95% CI: 3.6-54.7). No other antenatal factors were associated with AS5min < 7 (p > 0.05). The researchers concluded that repeated late decelerations on cardiotocography and prolonged second stage of labor in the low-risk population are predictors of AS5min < 7, a situation associated with increased risk of neonatal respiratory distress, need for mechanical ventilatory support and NICU, and hypoxic-ischemic-encephalopathy.

Sameshima H et al conducted a retrospective study of 10,030 term infants in two secondary and two tertiary level institutions, of which 5546 were low risk according to antenatal evaluation, to evaluate the clinical validity of electronic fetal heart rate monitoring in detecting fetal academia as well as the prevalence of cerebral palsy in unselected low risk pregnancies. The correlations between the fetal heart rate pattern and umbilical blood gases and the fetal heart rate pattern and cerebral palsy were studied and analysed by appropriate statistical tests. On the basis of the severity of decelerations, frequency of decelerations, and decreased variability, umbilical pH, and P_{O_2} level were decreased accordingly, and incidence of pH<7.1 was increased. Sensitivity and false-positive rate of nonreassuring fetal heart rate patterns for fetal acidemia were 63% and 89%. There were nine cerebral palsy cases: six of the cases were preexisting asphyxia before monitoring was initiated, two of the cases were cytomegaloviral infections, and one of the cases was a maternal amniotic fluid embolism. The researchers concluded that intrapartum fetal heart rate monitoring was useful to detect fetal academia and Cerebral palsy caused by intrapartum asphyxia was restricted to unavoidable accidents under continuous fetal heart rate monitoring.

Sandhu GS et al[24] conducted a prospective study on 150 high risk patients presenting in active labour during the first stage to predict the neonatal outcome in high risk obstetric cases by admission cardiotocography (CTG) testing. Specific fetal and neonatal measures assessed were development of fetal distress during labour, Apgar score 5 minutes after birth, admission to neonatal intensive care units (NICU), and incidence of intrapartum still birth/ neonatal mortality. The investigators found that fetal distress during labour developed in 15% of the patients with a normal test and in 73% of the patients wiyh an abnormal test. The admission test had a sensitivity of 66.7%, specificity of 93.3%, and a positive predictive value of 53.3% for predicting an Apgar

<5 at birth. The investigators concluded that admission cardiotocography testing could be used to identify patients likely to develop adverse fetal outcome and helps in optimisation of labour room resources.

Roy KK et al[25] conducted a prospective observational study of 217 patients who underwent caesarean section at ≥ 36 weeks for non-reassuring fetal heart pattern in labour detected by CTG and correlating those cases with the perinatal outcome to find out the efficacy of continuous fetal heart rate monitoring and to evaluate whether 30 minute decision to delivery interval influences perinatal outcome. Out of 3148 patients delivered at≥36 weeks, 217(6.8%) patiens underwent caesarean section during labour primarily for non reassuring fetal heart rate. The most common fetal heart abnormality was persistent bradycardia in 106(48.8%) cases followed by late deceleration in 38 (17.5%) cases and decreased beat to beat variability in 17 (7.8%) cases. In 33 babies (15.2%) the 5 minute Apgar score was<7 out of which 13 (5.9%) babies had cord blood ph<7.10. 33 babies (15.2%) required admission for birth asphyxia. The researchers concluded that fetal heart rate detected by CTG did not correlate well with adverse neonatal outcome. And there was no significant difference in adverse neonatal outcome whether the decision delivery interval was less than or more than 30 minutes.

Chauhan SP et al[26] studied interobserver variability in the classification of fetal heart rate (FHR) tracing with periodic deceleration as being reassuring or nonreassuring and in the ability to predict emergency caesarean delivery(ECD) or umbilical artery ph<7.00. 100 FHR tracings were reviewed by five clinicians 1 hour before abnormalities and , if applicable, 1 hour before delivery. Among 100 parturients, 46% of the women had ECD, and 2% of the women had low pH. The wighted Kappa coefficients (WKC) for the classification of the FHR tracing as reassuring or nonreassuring in early labour was -0.12 and before delivery was 0.15. the WKC for ECD was0.26 and for low pH was 0.21. The likelihood ratio for these 2 outcomes was<2.0. The researchers concluded that there was poor agreement among the clinicians who classified FHR as reassuring vs nonreassuring and were unable to identify as to which parturient would have ECD or low umbilical artery pH.

Hadar A et al [27] conducted a prospective study to evaluate perinatal outcomes of infants who had pathological fetal heart rate tracings during the first stage of labour, in comparison with pregnancies with normal tracings. The perinatal outcomes of 301 infants born at 37 to 42 weeks of gestation with pathologic fetal heart rate patterns during the first stage of labor were compared with 300 infants with normal fetal heart rate tracing patterns. Hydramnios (odds ratio, 7.68; 95% CI, 1.75%-33.63%), oligohydramnios (odds ratio, 2.74; 95% CI, 1.01%-7.39%), and the presence of meconium-stained amniotic fluid (odds ratio, 1.91; 95% CI, 1.03%-3.3%) were independent factors that were associated with pathologic fetal heart rate monitoring during the first stage of labour in a multivariable analysis. The occurrences of umbilical arterial pH of <7.20, a 1-minute Apgar score of <7, a base deficit of 12 mmol/L or higher, and operative deliveries were significantly higher in the study group as compared with subjects with normal fetal heart rate monitoring. Late decelerations and severe variable decelerations (<70 bpm) during the first stage of labor were independent risk factors (odds ratio, 17.5; 95% CI, 1.61%-185.7% and odds ratio, 3.9; 95% CI, 1.36%-11.7%, respectively) that were associated with fetal acidosis (determined by both pH of <7.2 and a base deficit of 12 mmol/L or higher) in a multiple logistic model, controlled for hydramnios, oligohydramnios, meconium-stained amniotic fluid, augmentation by oxytocin, nulliparity, duration of first stage of labor, and birth weight. The researchers concluded that operative delivery was higher among the patients with abnormal firs stage fetal heart patterns.

AIMS AND OBJECTIVE

To find out the role of cardiotocography in predicting perinatal outcome in high risk pregnancy.

III. Materials And Methods

STUDY

The study design was a prospective longitudinal study.

STUDY POPULATION

Term pregnant women having high risk factors attending antenatal clinic of a tertiary Hospital and subsequently getting admitted during the study period will be included in the study.

SAMPLE SIZE

250 term pregnant women having high risk factors admitted for safe confinement of pregnancy.

STUDY TOOLS

Cardiotocography machine/ fetal monitor
Model no F3 SN 330125-M13406060002,
cvvvcompany: EDAN
Ultrasound transducer MODEL: MS3-109301(D)
TOCO TRANSDUCER :MODEL MS3-31527(B)

STUDY VARIABLES

Maternal factors include religion, age, parity, demographic profile, literacy, high risk factors like post dated pregnancy, bad obstetric history, medical disorders, post caesarean pregnancy, anaemia., pregnancy induced hypertension (PIH), oligohydramnios, premature rupture of membranes, etc.

Cardiotopography results as per NICE guidelines: normal, nonreassuring, abnormal.

Fetal factors: Meconium stained liquor, NICU admissions, APGAR score at birth, Neonatal death.

INCLUSION CRITERIA

Patients booked for hospital delivery with gestational age ≥37 weeks, in latent phase or active phase of labour with the fetus in cephalic presentation and having any one of the following high risk facors:

◦Women with bad obstetric history.

◦Pregnancy with medical disorders (e.g.gestational diabetes mellitus, anaemia, thyroid disorders, bronchial asthma, etc.)

◦Pregnancy Induced Hypertension (PIH).

◦Postdated pregnancy.

◦ Premature Rupture of Membranes (PROM).

◦Oligohydramnios, Polyhydramnios.

◦Intrauterine Growth Restriction (IUGR).

◦Rh negative pregnancy.

EXCLUSION CRITERIA

◦Women with period of gestation<37 weeks.

◦Ultrasonography confirmed lethal congenital anomaly of the fetus.

◦Acute Hypoxic States such as abruption of the placenta, cord prolapsed, uterine scar rupture, etc.

◦Multiple pregnancies.

◦Abnormal lie and presentation needing immediate caesarean section.

◦Patients who were identified for elective caesarean section.

Patients who are not willing to be a part of the study.

DATA COLLECTION

An informed was taken from the patients willing to be a part of the study.Data was collected using a semistructured proforma regarding socio-demographic profiles like age, religion, economic status, literacy, occupation, etc. Data regarding obstetric and gynaecological history like medical history, drug history or any other high risk factors during the previous and the present pregnancy were collected. Intrapartum Cardiotography was done and the tracings were analysed according to NICE guidelines. Patients were followed up till delivery to know regarding the mode of delivery, fetal outcomes as regards APGAR score at 1 minute of birth, meconium stained liquor,NICU admissions or neonatal death and correlation made between CTG tracings and adverse perinatal outcome.

DATA ANALYSIS

Data was analysed by using descriptive statistics. Analysis was done using SPSS 21.0 version. Test of significance was carried out by using Chi-square test. P value of less than 0.05 was considered significant.

Table 1: Demographic profile

Variable	**Frequency (N)**	**Percentage (%)**
Age		
17-20	14	5.6
21-25	88	35.2
25-30	71	28.4
31-35	53	21.2
36-40	15	6
40-45	9	3.6
Occupation		
Employed	80	32
Un-eployed	170	68
Literacy		
Upto class VIII	63	25.2
Class VIII-X	22	8.8
Class X-XII	77	30.8
Graduate and above	88	35.2

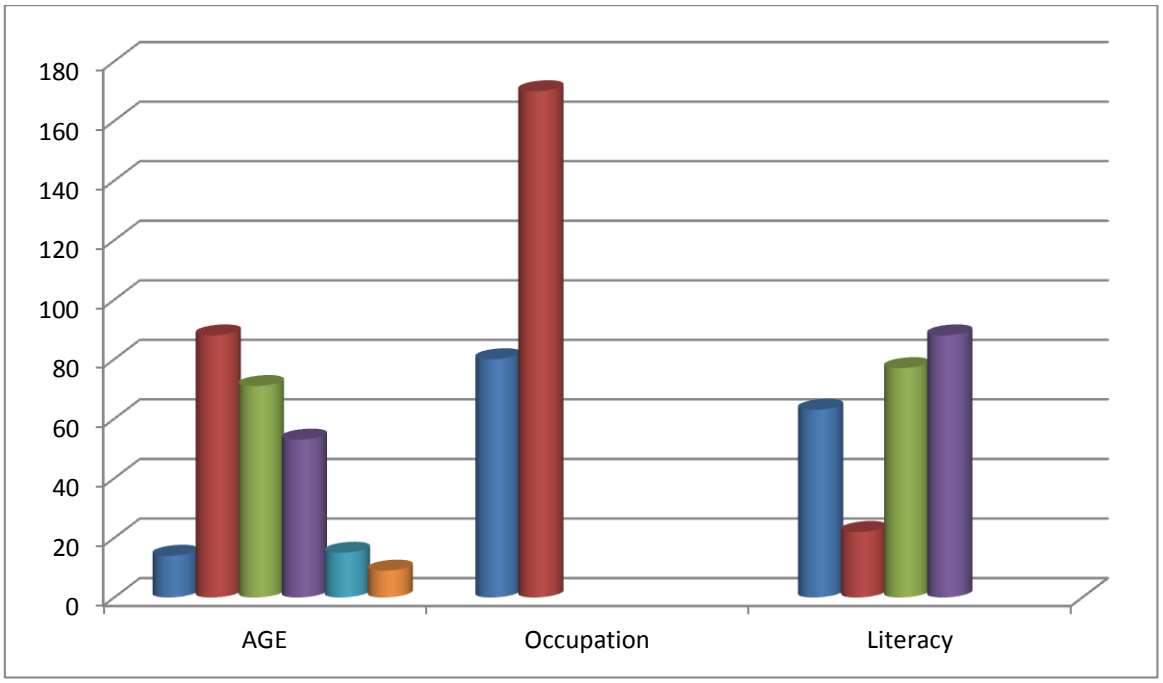

Fig.1: Bar chart showing distribution of Age, Occupation and Literacy

This table shows the distribution of age, occupation and literacy among the study population. Maximum number of women are in the age group 21-25 years (35%) and 68% of the women in the study group were unemployed. Around 35% of women were graduate and above and a quarter (25%) of women have studied upto class eight.

Table 2: Distribution of religion

Religion	Frequency (N)	Percentage (%)
Hindu	158	63.2
Christian	39	15.6
Muslim	41	16.4
Others	12	4.8

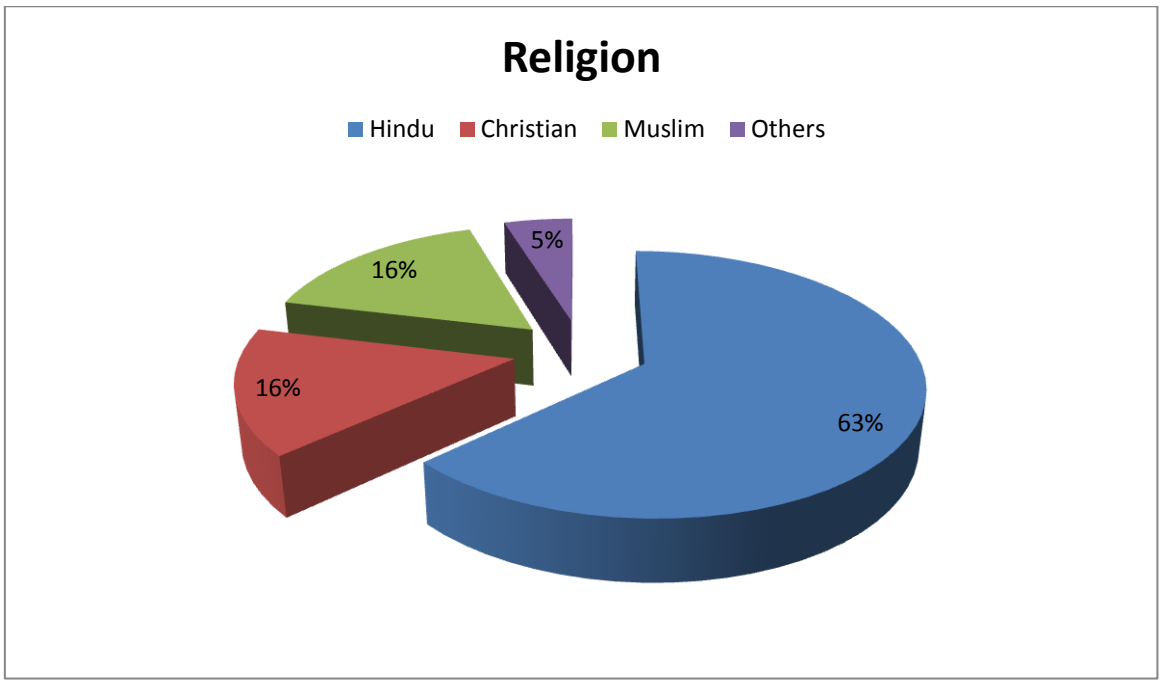

Fig. 2: Pie chart of distribution of Religion

Majority of the women in the study group were Hindus (63.2%). Christian and Muslim constitute similar proportions viz. 15.6% and 16.4%.

Table 3: Distribution of blood group

Blood group	Frequency (N)	Percentage (%)
A+	69	27.6
AB+	13	5.2
B-	2	.8
B+	75	30.0
O+	86	34.4
O-	5	2.0

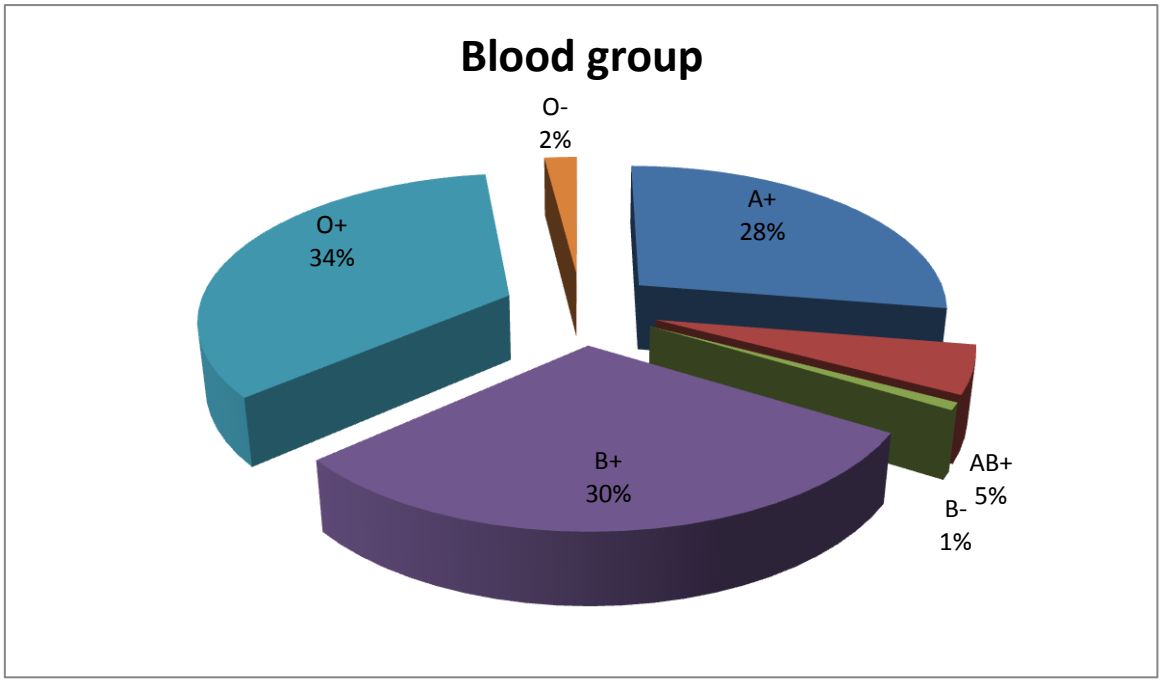

Fig.3: Pie chart showing the distribution of blood group

The most common blood group among the study population was O+ve which comprises 34.4% followed by B+ve which comprises 30% of the total study population. A total of seven Rh-ve cases were found in the study population

Table 4: Distribution of parity

Parity	Frequency (N)	Percentage (%)
Primigravida	121	48.4
Multigravida	129	51.6

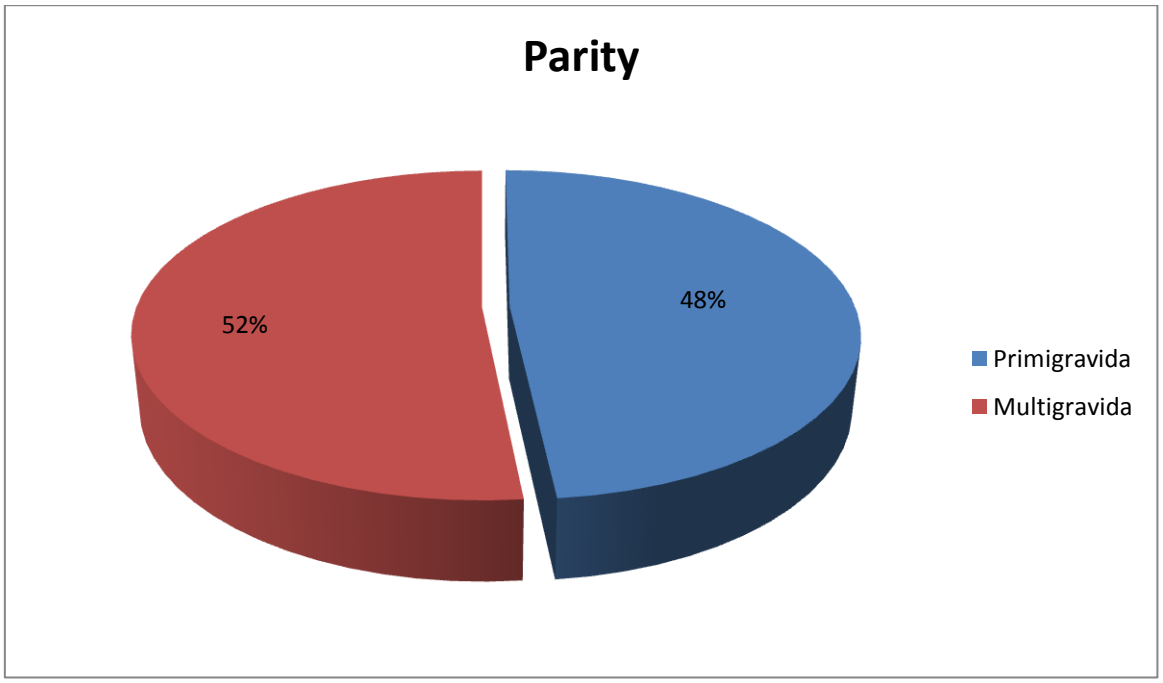

Fig.4: Pie chart showing the parity

This table shows the distribution of parity among the study population. More than half (51.8%) of the patients were multigravida.

Table5: Distribution of Gestational Age

Gestational age	Frequency (N)	Percentage (%)
37-40 weeks	123	49.2
> 40 weeks	127	50.8

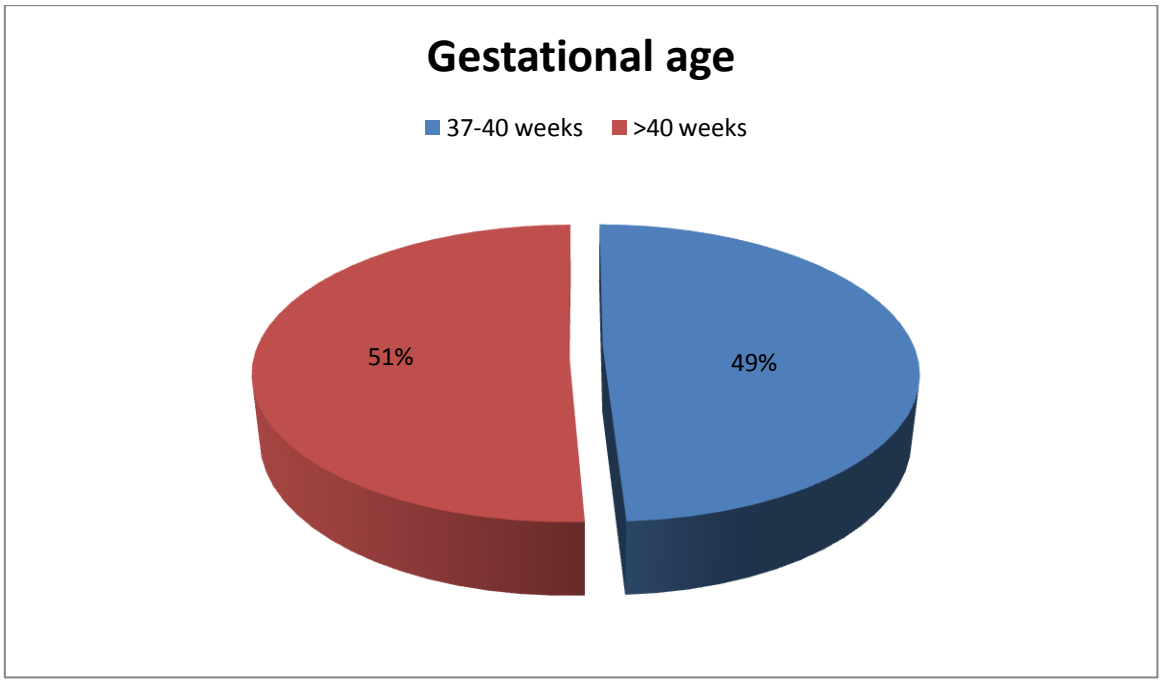

Fig.5: Pie chart showing Gestational age distribution

Table 5.shows the distribution of gestational age among the study population. Half of the pregnant women in the study population presented with gestational age above 40 weeks.

Table6: Risk factors in the study population

Risk factors	Frequency (N)	Percentage (%)
Post dated (PD)	99	39.6
BOH	17	6.8
Medical problems*	13	5.2
PIH	29	11.6
PROM	25	10.0
Oligohydraminos	24	9.6
Polyhydraminos	3	1.2
IUGR	13	5.2
RH -ve	7	2.8
PD & PROM	10	4.0
BOH &PD	5	2.0
PIH &Oligo& PD	5	2.0

*Hypertension, Type 2 DM, Hypothyroidism

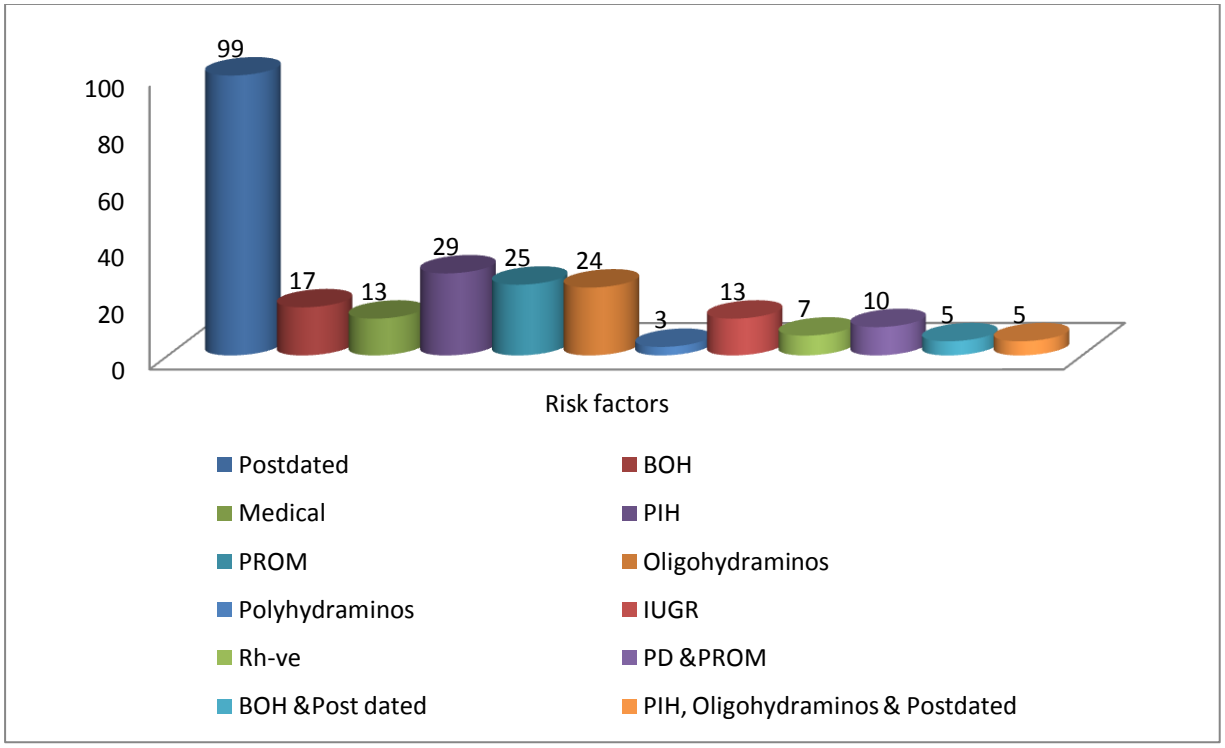

Fig.6: Bar diagram showing Risk factors in the study population

This table shows the distribution of different risk factors in the population. About 39.6% were Postdated pregnancy followed by PIH (11.6%), PROM (10%) and Oligohydraminos (9.6%).

Table7: Post Caesarean Pregnancy

Post caesarean pregnancy	Frequency (N)	Percentage (%)
Yes	32	12.8
No	217	86.8

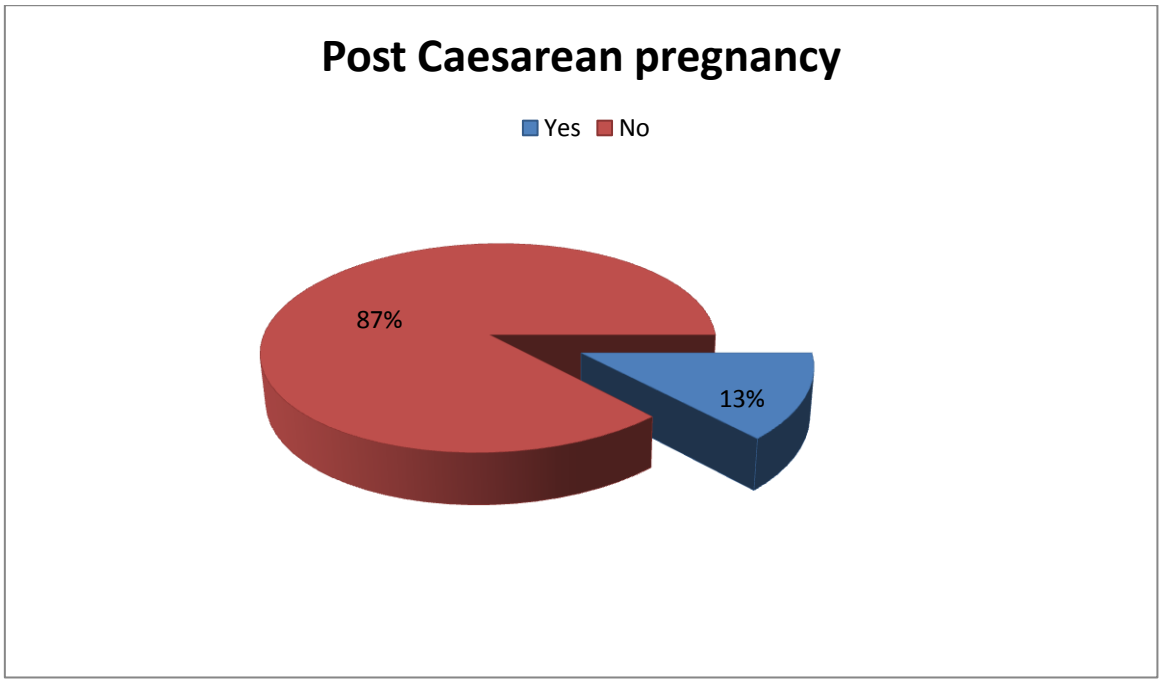

Fig.7: Pie chart showing distribution of post Caesarean Pregnancy

This pie chart shows the distribution of post caesarean pregnancy in the study population. Only 12.8% of women in the study population were post caesarean pregnancy.

Table 8. Mode of delivery

Modes of delivery	Frequency (N)	Percentage (%)
EMLSCS	117	46.8
NVD	106	42.4
Ventouse	27	10.8

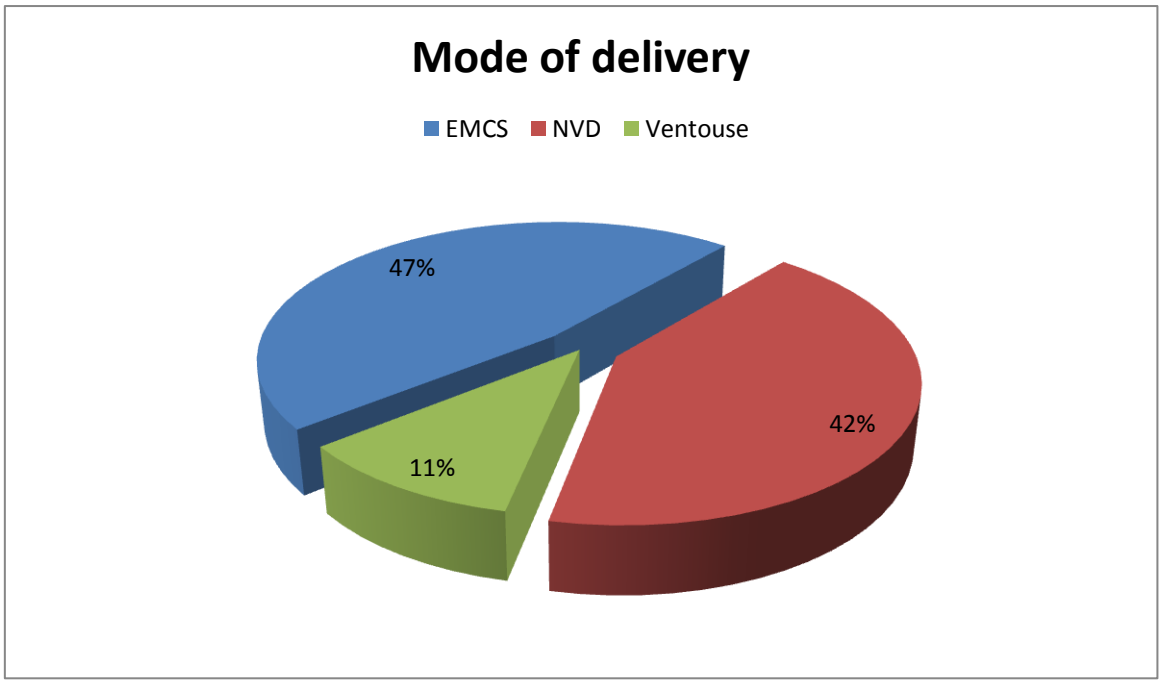

Fig.8: Pie chart showing mode of delivery

This table shows the different modes of delivery among the study population. Emergency LSCS was done among 117 (46.8%) of patients while Normal vaginal delivery was done in 106 (42.4%) of patients. Ventouse was performed in 10.8% of patients.

Table9. CTG result among study group

CTG result	Frequency (N)	Percentage (%)
Reassuring/Normal	188	75.2
Non-Reassuring	43	17.2
Abnormal	19	7.6

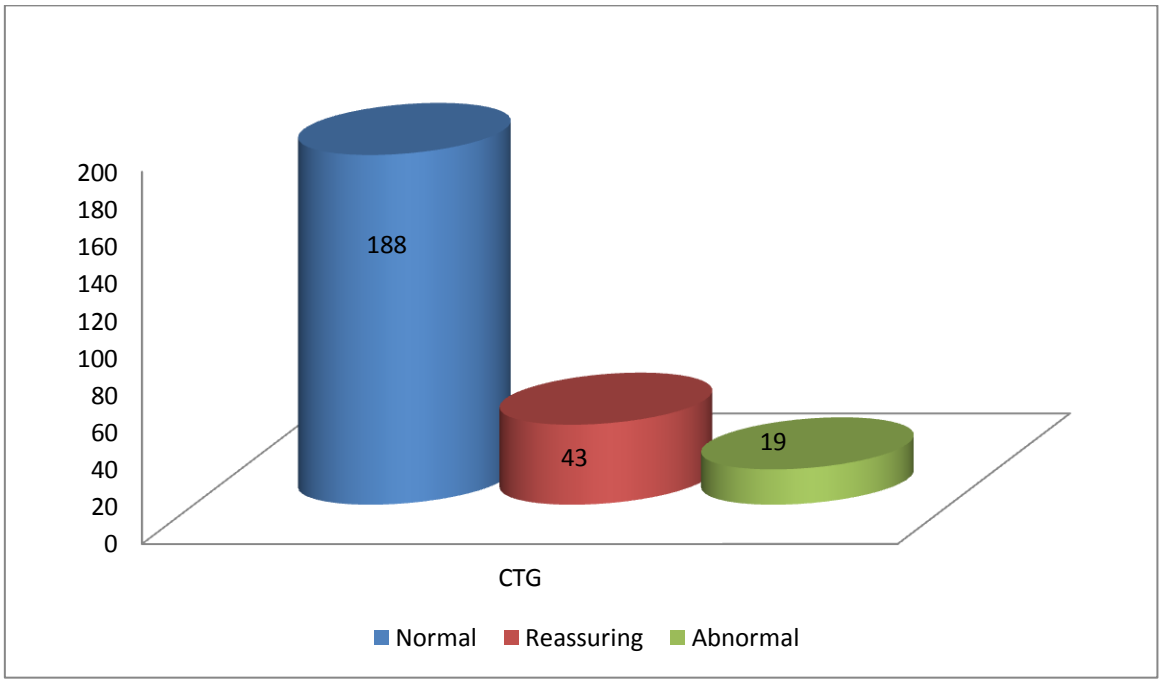

Fig.9: Bar diagram showing CTG result among study group

This table shows the Cardio-tocographic finding of 250 patients included in the study. Seventy-five percent of admission CTG were reassuring/Normal while 17.2% of patients were non-reassuring and 7.6% have abnormal CTG result.

Table 10.Anaemia among study population

Anaemia	Frequency (N)	Percentage (%)
Yes (<11gm/dl)	81	32.4
No (≥ 11gm/dl)	169	67.6

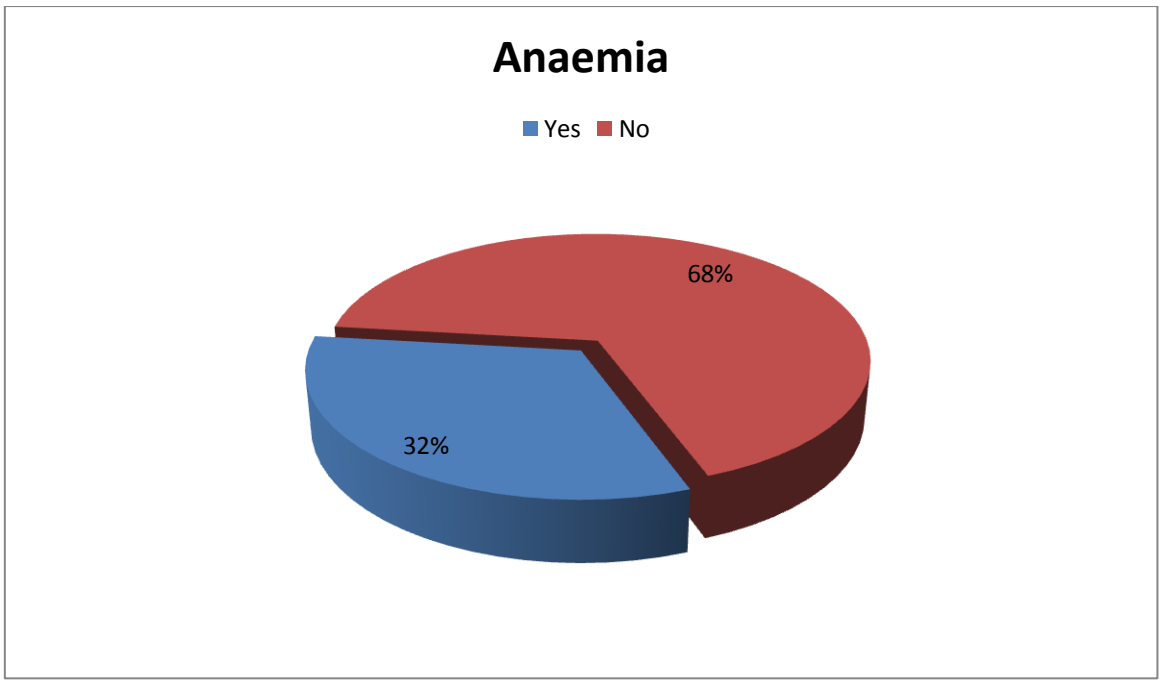

Fig. 10: Pie chart showing anaemia among study population

This table shows the distribution of anaemia among the study population. Thirty-two percent of the population wereanaemic.

Table 11. Birth weight

Birth weight	Frequency (N)	Percentage (%)
Low birth weight	24	9.6
Normal Birth weight	226	90.4

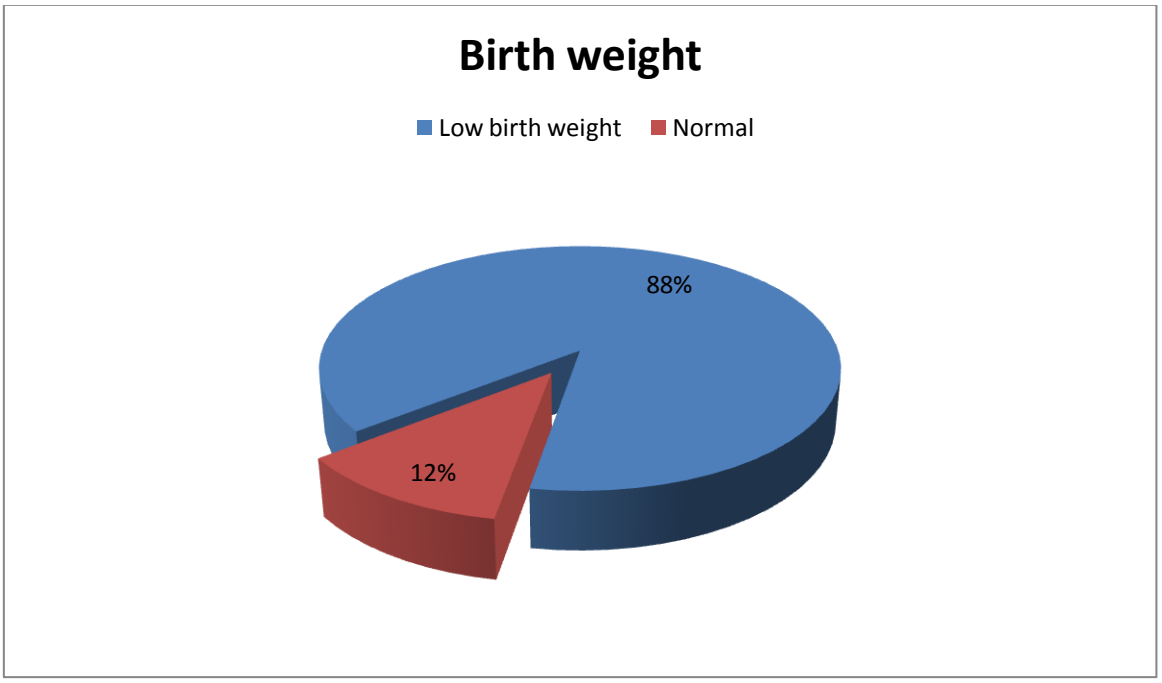

Fig.11: Pie chart showing birth weight among study population

This table shows the distribution of birth weight among the study population. Ninety percent of the babies have normal birth weight.

Table 12. Fetal distress among the study group

Fetal distress	Frequency (N)	Percentage (%)
Yes	53	21.2
No	197	78.8

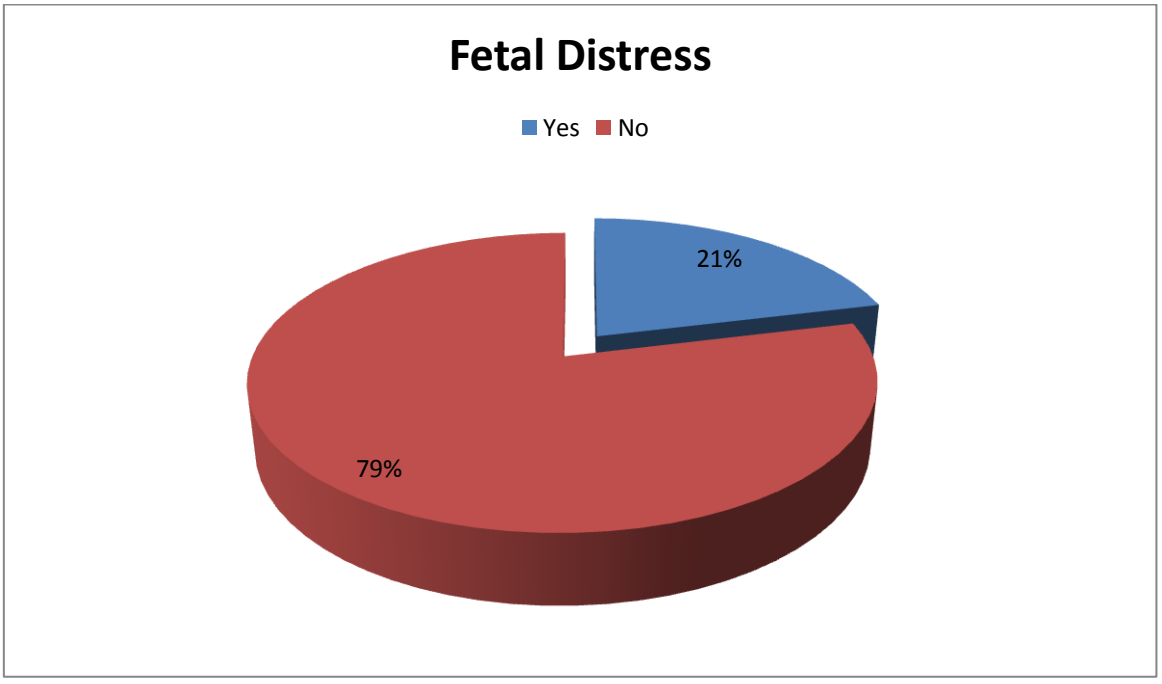

Fig.12: Pie chart showing fetal distress among study group

This table shows the incidence of fetal distress. Out of the total 250 patients 53 patients have fetal distress which accounts for 21% of the total population.

Table 13. Fetal outcomes among fetal distress

Fetal outcome	Frequency (N)	Percentage (%)
Meconium stained liquor		
Yes	35	66.0
No	18	34.0
Apgar score at 5 min <7		
Yes	24	45.3
No	29	54.7
NICU admission		
Yes	19	35.8
No	34	64.2
Neonatal death		
Yes	2	3.8
No	51	96.2

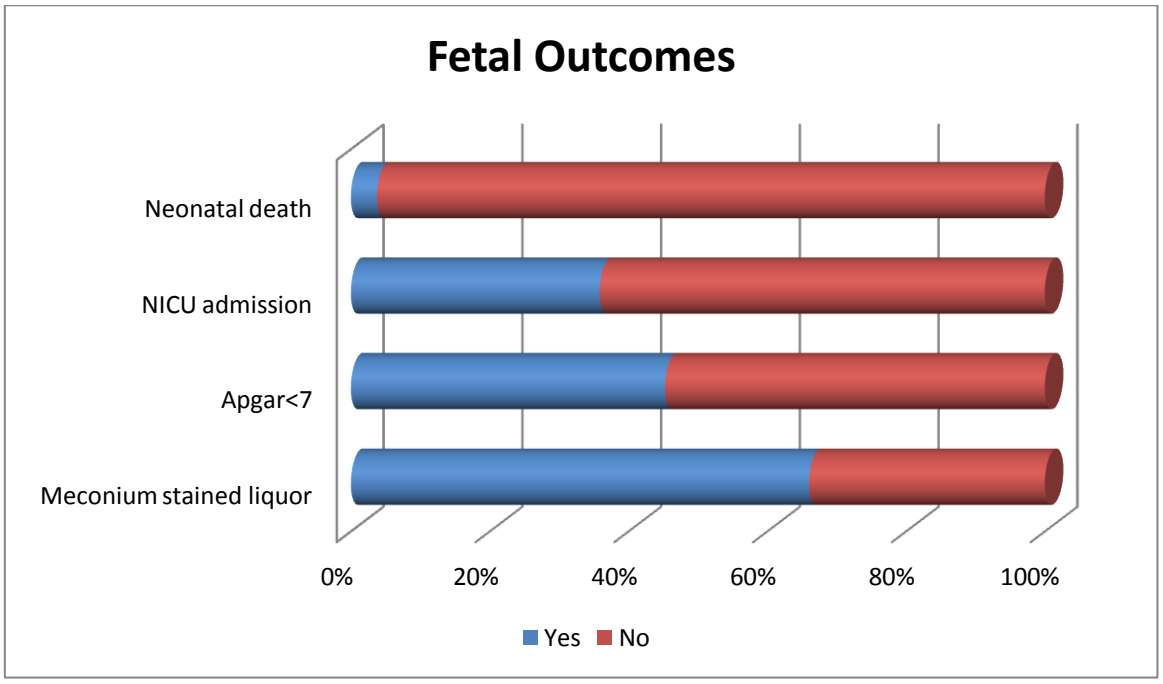

Fig.13: Bar diagram showing fetal outcomes among fetal distress

This table shows the different fetal outcomes among fetal distress. Out of total 53 fetal distress 35 (66%) have meconium stained liquor. The incidence of babies with APGAR score < 7 among fetal distress is 45.3%. There were 19 NICU admission and 2 neonatal deaths out of 53 babies with fetal distress.

Table 14: CTG result and incidence of fetal distress

CTG results	Fetal distress		P value
	Yes	No	
Reassuring/Normal	21 (11.2%)	167 (88.8%)	.000 df = 2
Non Reassuring	16 (37.2%)	27 (62.8%)	
Abnormal	16 (84.2%)	3 (15.8%)	

There is an increasing trend in fetal distress from Normal/ reassuring to abnormal CTG results. Eighty-four percent of fetal distress is seen among patients with abnormal CTG result which decreases to 37.2% among non-reassuring. The percentage of fetal distress further decreases to 11.2% in patients with reassuring/normal CTG results and the difference was found to be statistically significant (p< 0.000).

Table 15: CTG result and Mode of delivery

Mode of delivery	CTG result			P value
	Reassuring/Normal	Non Reassuring	Abnormal	
EMLSCS	79 (42.0%)	24 (55.8%)	14 (73.7%)	.026
NVD	90 (47.9%)	13 (30.2%)	3 (15.8%)	df = 4
Ventouse	19 (10.1%)	6 (14.0%)	2 (10.5%)	

There was a significant difference in the frequency of EMLSCS results among different categories of CTG result.. Among patients with abnormal CTG, 73.7% of patients underwent EMLSCS which is higher than non-reassuring (55.8%) and reassuring/normal (42%). Maximum number of NVD, 47.9% was done among patients with reassuring/normal CTG. Only 15.8% of patients with abnormal CTG had NVD. Ventouse was performed in 10.5% of patients with abnormal CTG.

Table 16: Incidence of fetal distress (FD) in specific risk factor groups

Risk factors	Normal/Reassuring		Non-Reassuring		Abnormal	
	Total	FD N (%)	Total	FD N (%)	Total	FD N (%)
Post dated (PD)	75	10 (13.3)	17	9 (52.9)	7	6 (85.7)
BOH	13	1 (7.7)	2	1 (50)	2	2 (100)
Medical problems	10	1 (10)	2	0 (0.0)	1	0 (0.0)
PIH	22	3 (13.6)	5	2 (40)	2	2 (100)
PROM	17	1(5.9)	6	1 (16.7)	2	1 (50)
Oligohydraminos	18	1 (5.6)	4	0 (0.0)	2	2 (100)
Polyhydraminos	3	0 (0.0)	0	0 (0.0)	0	0 (0.0)
IUGR	9	1 (11.1)	2	1 (50)	2	2 (100)
RH –ve	5	1 (20)	2	1 (50)	0	0 (0.0)
PD & PROM	8	1 (12.5)	1	0 (0.0)	1	1(100)
BOH &PD	5	1 (20)	0	0 (0.0)	0	0 (0.0)
PIH &Oligo& PD	3	0 (0.0)	2	1 (50)	0	0 (0.0)

This table shows the incidence of fetal distress in specific risk factor groups. Fetal distress increases with worsening of admission CTG. Fetal distress is seen in 85.7% of abnormal CTG, 52.9% of non-reassuring CTG and 13.3% of normal CTG among post dated patients. Among patients with BOH, PIH, Oligohydraminos and PD&PROM with abnormal CTG result 100% of patients develop fetal distress.

Table 17: Fetal/Neonatal outcome with CTG result

Fetal/Neonatal outcome	CTG result			P value
	Normal	Reassuring	Abnormal	
Meconium stained liquor				
Yes	16 (8.5%)	11 (25.6%)	10 (52.6%)	.000
No	172 (91.5%)	32 (74.4%)	9 (47.4%)	df = 2
Apgar score at 5 minute				
< 7	12 (6.4%)	6 (14.0%)	7 (36.8%)	.000
≥7	176 (93.6%)	37 (86.0%)	12 (63.2%)	df = 2
NICU admission				
Yes	10 (5.3%)	6 (14.0%)	5 (26.3%)	.003
No	178 (94.7%)	37 (86.0%)	14 (73.7%)	df = 2
Neonatal death				
Yes	0 (0%)	0* (0.00%)	2* (10.5%)	.013^
No	188 (100%)	43# (100.0%)	17# (89.5%)	

Cells * are clubbed and cells# are clubbed, ^ fisher exact test

This table shows the association between the incidence of Fetal/neonatal outcomes and CTG results. There was a statistically significant association between meconium stained liquor and CTG result. The incidence of meconium stained liquor increases with worsening admission CTG.More than half (52.6%) of Meconium stained liquor babies have abnormal CTG result while 25.6% and 8.5% of meconium stained liquor have non-reassuring and reassuring CTG results.

The incidence of babies with APGAR score <7 was highest among babies born to mothers with abnormal CTG result (36.8) as compared to non-assuring (14%) and normal (6.4%) CTG result and the difference was found to be statistically significant ($p < .000$).

There was a significant difference in the incidence of NICU admission among different CTG result. NICU admission increases with worsening admission CTG result. Twenty six percent of abnormal CTG have NICU admission as compared to 14% in non-reassuring and 5.3% in Normal CTG.

There was no neonatal death in normal and non-reassuring CTG result but 2 neonatal deaths were detected in babies born to mothers with abnormal CTG. Non reassuring and abnormal CTG were clubbed together and

fisher exact test was calculated. There was a significant difference (p=.013) in the incidence of neonatal death among babies born to mothers with normal CTG and non-reassuring and abnormal CTG.

Table 18:Mode of delivery with CTG result among FD

Fetal/Neonatal outcome	CTG result			P value
	Normal	Non-Reassuring	Abnormal	
EMLSCS	79	24	14	
With FD	8 (10.1%)	8 (33.3%)	14 (100.0%)	.000
Without FD	71 (89.9%)	16 (66.7%)	0 (0.0%)	
NVD	90	13	3	
With FD	8 (8.9%)	3 (23.1%)	0 (0.0%)	.245
Without FD	82(91.1%)	10(76.9%)	3(100.0%)	
Ventouse	19	6	2	
With FD	5 (26.3%)	5 (83.3%)	2 (100.0%)	.013
Without FD	14 (73.7%)	1 (16.7%)	0 (0.0%)	

This table shows the incidence of mode of delivery with the result of the admission CTG result and the occurance of fetal distress. There was a significant association between the incidence of EMLSCS and CTG result. Those who underwent EMLSCS in Normal admission CTG, only 10.1% (8/79) were the indication of fetal distress whereas 33.3% of EMLSCS in non- reassuring CTG were due to fetal distress. In case of abnormal CTG all the EMLSCS were due to fetal distress.

Out of the total 90 NVD among normal CTG only 8 (8.9%) had fetal distress. In case of Non-reassuring CTG 23.1% had fetal distress but no NVD was done for fetal distress with abnormal CTG although the difference were not statistically different.

Twenty six percent of babies with fetal distress among normal CTG were delivered by ventouse whereas it is 83.3% for non-reassuring and 100% for abnormal CTG and the difference were found to be statistically significant.

IV. Discussion

The use of Cardiotocography forfetal heart rate monitoring has been employed by many centres to identify fetuses that are at an increased risk of hypoxia. Electronic fetal monitoring (EFM) can detect hypoxia early and avoid unnecessary delay in intervention, its advantage being it is a non invasive procedure and a highly logical solution to the undeniable human lapses of manual fetal heart rate monitoring. The uterine contractions serve as a functional stress to the fetus and can help to identify those fetuses that are already hypoxic and are at an increased risk of developing hypoxia during labour.[8] Several factors, including gestational age and medications administered to the mother can affect the FHR features, so CTG analysis needs to be integrated with other clinical information for a comprehensive interpretation and adequate management.[31]

In our study, the role of cardiotocography in predicting perinatal outcome in high risk pregnancy was evaluated. Most of the patients were in the age group of 21-30 years (63.6%) which is comparable to the study conducted by Rahman H et al[8] (73.8%) and Bhagdiya S et al[35] (61%). In our study multigravidas (51.6%) were present in majority which is similar to study conducted by David B et al[33]whereas in the study conducted by Rahman H et al[8](61.9%) and Nikita V et al[36] (62%) primigravidas constituted the majority. More than half of the women in our study had gestational age more than 40 weeks (50.8%) which is different to the study done by Rahman H et al[8] where the majority had gestational age less than 40 weeks (58.2%). In another study conducted by Kaban A et al[1]no significant difference in maternal age or parity was found between the group with fetal distress based on CTG and the normal group.

Among the high risk factors that were present in our study, post dated pregnancies constituted were the highest (39.6%) which is similar to the study conducted by Rahman H et al[8] (41.8%). In our study 2.8% of the mothers were having Rh negative blood group which is comparable with the study done by Rahman H et al[8].

In our study, majority of the patients were delivered by emergency LSCS (46.8%), normal vaginal delivery (NVD) was done in 42.4% and ventouse was done in 10.8% where as in the study done by Panda S et al[30]vaginal delivery was done in 80% of the cases and emergency LSCS was done in 20% of the cases.

In our study, Cardiotocography results showed normal in case of 188 patients(75.2%), non-reassuring in case of 43 patients (17.2%) and abnormal in case of 19 patients (7.6%) which is similar to the study conducted by Sandhu GS et al[24] in which the results were normal in 101 (67%) patients, non-reassuring in case of 34 (23%) and abnormal in case of 15(10%) patients. Similar results were seen by the study done by Rahman H et al[8] which showed normal in case of 123 (76.9%) patients, non-reassuring in case of 23(14.4%) patients and abnormal in case of 14 (8.7%) patients.

In our study we defined fetal distress if there was meconium stained liquor, Apgar score <7 at 5 minutes, NICU admissions or neonatal death. Similar working definition for fetal distress were adopted in the Indian studies done by Rahman H et al[8]. 53 (21.2%) neonates had distress and fulfilled the above mentioned criteria in our study whereas it was 21.8% in the study by Rahman H et al[8]. The incidence of fetal distress was found to be 11.2% in the normal group, 37.2% in the non-reassuring group, and 84.2% in abnormal group which is similar to the results reported by Rahman H et al[8](11.3% in the normal group, 39.1% in the non-reassuring group and 85.7 in the abnormal group.)Odongo BE et al[17] reported no significant difference in the mean birth weights of the infants born to women in high risk and low risk group which is comparable to the results obtained in our study in which no significant differences were noted in relation to birth weight.

The incidence of birth asphyxia was greater in the non-reassuring test group (14%) and abnormal test groups (36.8%) as compared to the normal group (6.4%) which is comparable to the results reported by Panda S et al[30] (78.57% in the non-reassuring and abnormal group). The incidence of meconium stained liquor was 16 (8.5%) in the normal group, 11(25.6%) in the non-reassuring group and 10(52.6%) in the abnormal group which is comparableto that reported by Rahman H et al[8](normal 8.9%, non-reassuring 39.1% and 71.4% in abnormal group). In our study NICU admissions occurred in 10(5.3%) neonates in the normal group, 6 (14%) in case of the non-reassuring group and 5(26.3%) neonates in the abnormal group which is comparable to the results obtained by Sandhu GS et al[24] (normal 1%, non-reassuring 12% and abnormal 33%). From the above observations, it can be seen that the occurrence of adverse neonatal outcomes increases significantly with worsening of CTG results which is comparable to that reported by XuH et al[14].

In our study emergency LSCS occurred in 79 (42%) patients whose CTG was categorised as normal, 24 (55.8%) patients in the non-reassuring group and 14 patients(73.7%) in the abnormal group which are comparable with the results reported by Rahman H et al[8] (normal 35.8%, non-reassuring 43.5%, abnormal 78.6%). Occurence of NVD was higher in the normal group (47.9%) comparable to results reported by Rahman H et al[8] (52.8%).Panda S et al[30] reported an increased occurrence of NVD (89.53%).Ventouse delivery was more common in the non-reassuring group (14%) whereas Rahman H et al[8] reported higher incidence in the normal group (11.4%). David B et al[33] reported similar incidence of emergency LSCS in 100 % of the patients having abnormal test results on CTG.

In our study the occurrence of abnormal CTG was high in postdated pregnancy and the occurrence of fetal distress was also high in the same group (85.7%) which is comparable with the results reported by Rahman H et al[8].

There was an increasing incidence of fetal distress from normal CTG result to abnormal CTG result which is comparable to the results reported by David B et al[33]. The incidence of fetal distress significantly increases with worsening of CTG.

Table showing Comparison showing the sensitivity, specificity, positive predictive value and negative predictive value in different studies

	SENSITIVITY	SPECIFICITY	POSITIVE PREDICTIVE VALUE	NEGATIVE PREDICTIVE VALUE
Panda S et al[30]	57.89%	96.30%	78.57%	90.70%
Resh P et al[11]	87.50%	87.50%	98.98%	33.33%
David B et al[33]	92.85%	94.16%	87.96%	96.62%
Bogdanovic G et al[7]	66%	27%	80%	
Kaban A et al[1]	79%	85%	68%	91%
Rahman H et al[8]	60%	94.8%	56.8%	88.6%
Sultana J et al[13]	87%	66%	54%	92%
Present study	60.4%	84.8%	51.6%	88%

The sensitivity of CTG in predicting adverse perinatal outcome in high risk pregnancy was found to be 60.4% which is comparable to the results reported by Rahman H et al[8](60%), Panda S et al[30] (57.89%). Sultana J et al[13] reported sensitivity of 87% which is higher comparable to our study. The difference is probably because of the different methods of selection of the study sample and study settings. In our study we can observe that CTG can diagnose fetal distress with an accuracy of 60.4 % whereas the specificity of the test is even higher 84.8% which means that a normal category of CTG largely rules out fetal distress and hence CTG in high risk pregnancy is a good predictor of fetalwell being.

References

[1]. Kaban A, Cengiz H, Kaban I, Özcan A, Karkas S. The success of cardiotocography in predicting perinatal outcome. J Clin Exp Invest 2012;3(2):168-71.

[2]. Alfirevic Z, Devane D, Gyte GML. Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) during labour. Cochrane Database Syst Rev [serial online]. 2013 [cited 2016 Sep 5];(5):[7 screens]. Available from: URL: http://www.cochrane.org/CD006066.

[3]. Edwin C, Arulkumrn S. Electronic fetal heart rate monitoring in current and future practice. J Obstet Gynecol India. 2008;58(2):121-30.

[4]. Cunningham GF, Leveno JK, Bloom LS, Spong YC, Dashe SJ, Hoffman LB et al, editors. Williams OBSTETRICS. 24 th ed. New York. McGraw-Hill; 2014.

[5]. Holzmann M, Wretler S, Cnattingius S, NordstrÖm L. Cardiotocography patterns and risk of intrapartum fetal acidaemia. J Perinat Med 2015;43(4):473-9.

[6]. Sharbaf FR, Amjadi N, Alavi A, Akbari S, Forghani F. Normal and indeterminate pattern of fetal cardiotocography in admission test and pregnancy outcome. J Obstet Gynaecol Res 2014;40(3):694-9.

[7]. Bogdanovic G, Babovic A, Rizvanovic M, Ljuca D, Grgic G, Milicic DJ. Cardiotocography in the Prognosis of Perinatal Outcome. Med Arh 2014;68(2):102-5.

[8]. Rahman H, Renjhen P, Dutta S, Kar S. Admission cardiotocography: Its role in predicting foetal outcome in high-risk obstetric patients. Australas Med J 2012;5(10):522-7.

[9]. Devane D, Lalor JG, Daly S, McGuire W, Smith V. Cardiotocography versus intermittent auscultation of fetal heart on admission to labour ward for assessment of fetal wellbeing (Review). Cochrane Database Syst Rev 2012 [cited 2016 Sep 6];(2):[36 screens]. Available from: http://img2.timg.co.il/forums/1_159662992.pdf.

[10]. Grivell RM, Alfirevic Z, Gyte GML, Devane D. Antenatal cardiotocography for fetal assessment (Review). Cochrane Database Syst Rev 2015 [cited 2016 Sep 8];(9):[3 screens]. .Available from: URL: http://onlinelibrary.wiley.com./doi/10.1002/14651858.CD007863.pub4/pdf`/abstract.

[11]. Resh P, Vishwanatha AC, Sujani BK. Admission Test Cardiotocography During Labour as a Predictor of Fetal Outcome. JK Pract 2011;16(1-2):43-9.

[12]. Daly N, Brennan D, Foley M, O'Herlihy C. Cardiotocography as a predictor of fetal outcome in women presenting with reduced fetal movement. Euro J Obstet Gynecol Reprod Biol 2011;159(1):57-61.

[13]. Sultana J, Chowdhury TA, Begum K, KhanMH. Mymensingh Med J 2009;18(Suppl 1):103-7.

[14]. Xu H, Mas-Calvet M, Wei SQ, Luo ZC**.** Abnormal fetal heart rate tracing patterns in patients with thick meconium staining of the amniotic fluid: association with perinatal outcomes. Am J Obstet Gynecol 2009;200(3):283-7.

[15]. Shiekh SM, Kamruddin A, Setna F, Riaz T. Role of pathological cadioocography in evaluating fetal well-being. J Coll Physicians Surg Pak 2006;16(6):404-7.

[16]. Impey L, Reynolds M, MacQuillan K, Gates S, Murphy J, Sheil O. Admission cardiotocography: a randomised controlled trial. Lancet 2003;361(9356):465-70.

[17]. Odongo BE, Ndavi PM, Gachuno OW, Sequeira E. Cardiotocography and perinatal outcome in women with and without meconium stained liquor. East Afr Med J 2010;87(5):199-204.

[18]. Schifrin BS. The CTG and the timing and mechanism of fetal neurological injuries. Best Pract Res Clin Obstet Gynaecol 2004;18(3):437-56.

[19]. Murray DM, O'Riordan MN, Horgan R, Boylan G, Higgins JR, Ryan CA. Fetal heart rate patterns in neonatal hypoxic-ischemic encephalopathy: relationship with early cerebral activity and neurodevelopmental outcome. Am J Perinatol 2009;26(8):605-12.

[20]. Blix E. The admission CTG: is there any evidence for still using the test?. Acta Obstet Gynecol Scand 2013;92(6):613-9.

[21]. Gourounti K, Sandall J. Admission cardiotocography versus intermittent auscultation of fetal heart rate: effects on neonatal APGAR score, on the rate of caesarean sections and on the rate of instrumental delivery—a systematic review. Int J Nurs Stud 2007;44(6):1029-35.

[22]. Salustiano EM, Campos Ja, Ibidi SM, Ruano R, Zugaib M. Low Apgar scores at 5 minutes in a low risk population: maternal and obstetrical factors and postnatal outcome. Rev Assoc Med Bras 2012;58(5):587-93.

[23]. Sameshima H, Ikenoue T, Ikeda T, Kamitomo M, Ibara S. Unselected low-risk pregnancies and the effect of continuous intrapartum fetal heart rate monitoring on umbilical blood gases and cerebral palsy. Am J Obstet Gynecol 2004;190(1):118-23.

[24]. Sandhu GS, Raju R, Shaktivardhan. Admission Cardiotocography Screening of High Risk Obstetric Patients. Med J Armed Forces India 2008;64(1):43-5.

[25]. Roy KK, Baruah J, Kumar S, Deorari AK, Sharma JB, Karmakar D. Cesarean section for suspected fetal distress, continuous fetal heart monitoring and decision to delivery time. Indian J Pediatr 2008;75(12):1249-52.

[26]. Chauhan SP, Klauser CK, Woodring TC, Sanderson M, Magann EF, Morrison JC. Intrapartum nonreassuring fetal heart rate tracing and prediction of adverse outcomes: interobserver variability. Am J Obstet Gynecol 2008;199(6):623-5.

[27]. Hadar A, Sheiner E, Hallak M, Katz M, Mazor M, Shoham-Vardi I. Abnormal fetal heart rate tracing patterns during the first stage of labor: effect on perinatal outcome. Am J Obstet Gynecol 2001;185(4)863-8.