ANTEPARTUM CEREBROPLACENTAL RATIO IN LOW RISK PREGNANCY AND ITS RELATIONSHIP WITH ADVERSE PERINATAL OUTCOME - A PROSPECTIVE COHORT STUDY

THESIS

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DECLARATION

I hereby declare that the thesis titled "**Antepartum cerebroplacental ratio in low risk pregnancy and its relationship with adverse perinatal outcome - A prospective cohort study**" embodies the original work carried out by the undersigned in All India Institute of Medical Sciences, Jodhpur.

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Dedicated to

My Father, Shakti Singh Rathore

And

My Mother, Santosh Shekhawat

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LIST OF ABBREVIATIONS

Short Form	Full Form
FGR	Fetal growth restriction
CPR	Cerebroplacental ratio
PI	Pulsatility index
NICU	Neonatal intensive care unit
CTG	Cardiotocography
ACOG	American College of Obstetrician and Gynecology
IUGR	Intrauterine growth restriction
AGA	Appropriate for gestational age
SGA	Small for gestational age
EFWt	Estimated fetal weight
S/D	Systolic/diastolic
PSV	Peak systolic flow
UA	Umbilical artery
MCA	Middle cerebral artery
DV	Ductus venosus
TTTS	Twin twin transfusion syndrome
TAPS	Twin anemia polycythemia sequence
NST	Non stress test
HIE	Hypoxic ischemic encephalopathy
ARM	Artificial rupture of membranes
ECG	Electrocardiography
FHS	Fetal heart sounds
SFH	Symphysiofundal height
EG	Example
MOM	Multiples of median
HCG	Human chorionic gonadotropin
USG	Ultrasonography
AFI	Amniotic fluid index
BPS	Biophysical profile

FPR	False positive rate
DR	Detection rate
PPV	Positive predictive value
NPV	Negative predictive value
CI	Confidence interval
RI	Resistance index
POG	Period of gestation
HIV	Human immunodeficiency virus
GDM	Gestational diabetes mellitus
ICA	Internal carotid artery
PPROM	Preterm Premature rupture of membranes
SPSS	Statistical Package for Social Sciences
FHR	Fetal heart rate
ACA	Anterior carotid artery
MSL	Meconium stained liquor
SD	Standard deviation
IUD	Intrauterine fetal death
OR	Odds ratio
CPAP	Continuous positive pressure ventilation
PPV	Positive pressure ventilation
AUC	Area under curve

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SUMMARY

Background:

Cerebroplacental ratio (CPR) is defined as middle cerebral artery PI (pulsatility index) divided by umbilical artery PI (pulsatility index). It is a novel predictor of perinatal outcome and has better sensitivity in comparison to umbilical artery doppler alone. A low Cerebroplacental ratio (CPR) shows compensatory fetal circulatory changes due to adverse intrauterine environment. CPR can be used along with estimated fetal weight to screen both high and low risk populations. We conducted a prospective study in women with low risk pregnancy between 35- 37+6 weeks gestation, if CPR assessment increase the frequency of identifying adverse perinatal outcomes.

Aims and Objectives:

We conducted a prospective study to assess the relationship between cerebroplacental ratio (CPR) and perinatal outcome in low-risk pregnancy

We also aimed to find out the incidence of abnormal CPR (cut off taken as $<10^{th}$ centile) in low-risk pregnancy and its relationship with non-reassuring /abnormal cardiotocography (CTG) tracing during labour.

The incidence of operative delivery, birth weight, NICU admission, meconium-stained liquor, and APGAR scores in abnormal and normal cerebroplacental ratio CPR were also evaluated.

Materials & Methods:

We conducted a prospective cohort study at our institute for a period of 1.5 years . Participants included 18 – 35years old women with low risk singleton pregnancies having cephalic presentation. Ultrasound was done between 35 to 37 + 6 weeks gestation along with fetal biometry, middle cerebral artery and Umbilical artery Doppler for CPR calculation.

Patients were divided into two groups according to ultrasonography findings with normal and abnormal CPR.

Maternal and neonatal outcomes were compared between abnormal CPR ($<10^{th}$ centile) and those with normal CPR ($>10^{th}$ centile).

Results

A total number of 172 cases were enrolled. CPR was abnormal in 55(31.97%) patients and normal in 117(68.02%) patients. In the abnormal CPR group, CTG (cardiotocography) tracing was reassuring in 61.81 %, non-reassuring in 18.18 % and abnormal in 20%. While in the normal CPR group, CTG tracing was reassuring in 81.19%, non-reassuring in 11.11% and abnormal in 7.69% (p=0.027). Caesarean and operative vaginal delivery rate was 45.45% and 5.45 % in abnormal CPR group while 40.17 % and 2.5% in normal CPR group, respectively (p value=0.63, 0.33). Lower birth weight was observed in 45.45 % women in abnormal CPR group, while 21.36% women had low birth weight in normal CPR group (p value=0.006). No significant difference was found in APGAR score and NICU admissions between the two groups (p value-0.94, 0.87).

Conclusion

We concluded from our study that there was an increased rate of abnormal CTG tracings and increased incidence of low birth weight in low risk women with abnormal CPR (<10^{th} centile). Operative delivery rate was also higher in abnormal CPR group, although other perinatal outcomes were comparable.

However, CPR measurement has a good negative predictive value to stratify women who may benefit from CTG monitoring.

INTRODUCTION

According to ACOG (American college of Obstetrics and Gynecology) intrauterine growth restriction (IUGR) is described as "one the most common and complex problems in modern obstetrics." As detection rate is low and there are few preventive and treatment options. Fetal growth restriction (FGR)is becoming a common obstetrical complication owing to uteroplacental insufficiency resulting in birth asphyxia and fetal morbidity and mortality. Need of the hour is to early identify FGR, adequate fetomaternal surveillance and plan timing of delivery [14 28.]

Uteroplacental insufficiency may present as SGA (small for gestational age) or if it develops late may also undergo undetected and present as AGA (appropriate for gestational age) babies [1 15 16].

According to ACOG, fetal growth restriction is defined as "fetuses with an estimated fetal weight or abdominal circumference that is less than the 10th percentile for gestational age", Small for gestational age (SGA) is defined as "newborns whose birth weight is less than the 10th percentile for gestational age".

Intrapartum fetal hypoxia can lead to 10-15 % cases of cerebral palsy, incidence of HIE is 2-3/1000 term fetus in developed countries [6 27]. Identification of these fetus with high risk of intrapartum fetal compromise is challenging. Cardiotocography (CTG) monitoring is useful but has not decreased the incidence of cerebral palsy. Fetal hypoxia leading to still birth and cerebral palsy are more common in FGR, so it necessitates the need of early identification of such pregnancies .[5 29 30 31 34]

Doppler has been known as a good modality for assessing fetal circulation and it can be used for surveillance of high risk pregnancy[3]. It can also identify AGA pregnancies which are complicated by placental insufficiency.[5 32 33] During uteroplacental insufficiency there is increased placental resistance while blood flow to cerebral arteries increases resulting in decreased middle cerebral artery resistance [1 17 18]

Ultrasound has 52-57% sensitivity for detecting SGA. Fetus with appropriate EFWt but uteroplacental insufficiency are not detected by routine ultrasound.[1 22] Doppler is done to evaluate Umbilical artery, middle cerebral artery, ductus venosus and uterine arteries

Following doppler parameters indices are commonly used in evaluation of uteroplacental insufficiency:

- PSV (peak systolic velocity),
- S/D (systolic diastolic ratio),
- PI (pulsatility index),
- CPR (cerebroplacental ratio)[9].

Umbilical artery:

Starting from 14 weeks low resistance in umbilical artery permits forward blood flow to fetus.

When multiple small vessels have obliterated flow, it leads to FGR and oligohydramnios. It results in changes in diastolic flow which can be decreased, absent or reversed (obliteration of >70% placental villi). PI is used in absent flow as S/D cannot be measured.

Method of measurement: abdominal insertion is preferred but other sites can also be used [9 17]

Umbilical artery doppler is used in surveillance of placental insufficiency, IUGR and suspected preeclampsia as UA (umbilical artery) PI increases in response to placental insufficiency[1 18 19 20].

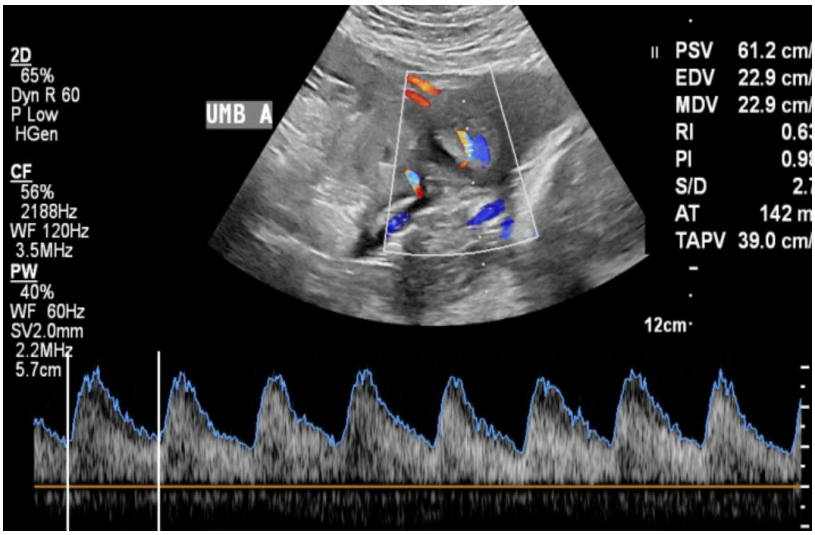

Figure 1: Normal Umbilical artery doppler

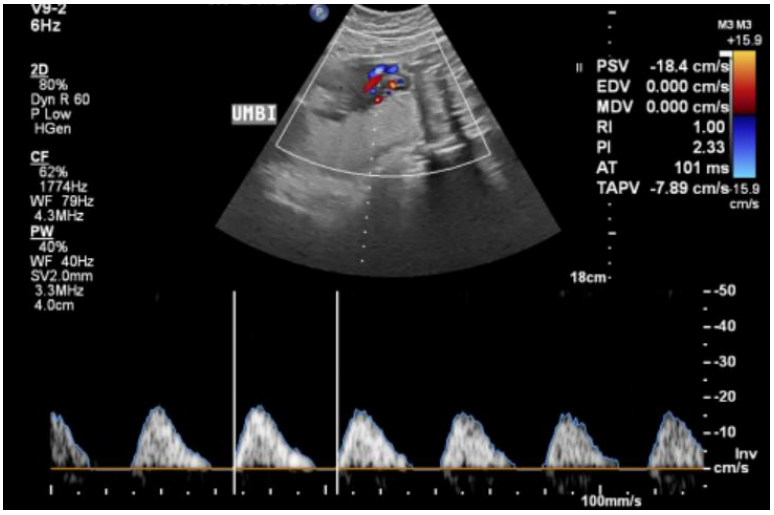

Figure 2 : Absent diatolic flow in umbilical artery

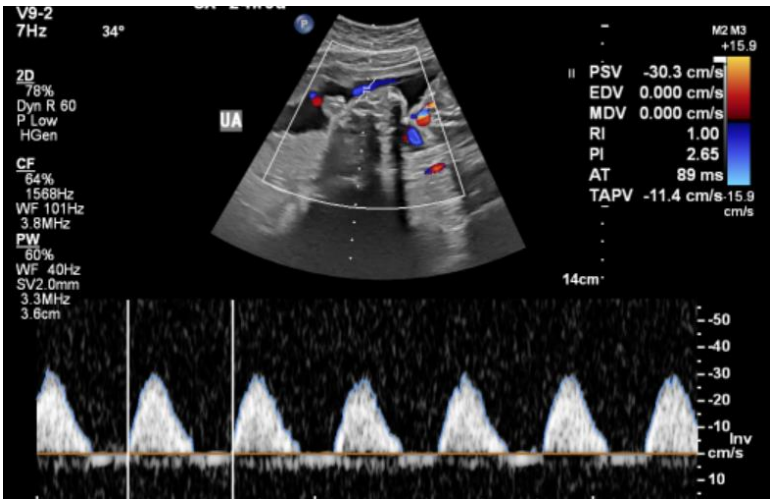

Figure 3 : Reversal of flow in umbilical artery

Middle cerebral artery:

It is a high resistance vessel, branch of internal carotid artery, constituting 80% of cerebral circulation. Doppler velocities are measured at proximal end of MCA near circle of Willis at base of skull. It is the most assessable cerebral vessel for measurement. [9 17 20 38]

The resistance in Middle cerebral artery (MCA)is high in perinatal period normally but in placental insufficiency and hypoxemia due to stimulation of chemoreceptors and vasodilators the diastolic flow increases and resistance decreases leading to decrease in PI[6].

The middle cerebral artery (MCA) shows a brain sparing effect which is characterized by decrease in MCA PI as a response to hypoxemia because the fetus centralizes the blood flow to brain. [9 17 20 38].

Middle cerebral artery (MCA) doppler is essential for assessing fetal cardiovascular distress, fetal hypoxia and fetal anemia. Middle cerebral artery (MCA) is also used in workup of intrauterine growth restriction (IUGR), twin twin transfusion syndrome (TTTS) and twin anemia polycythemia sequence (TAPS)[10].

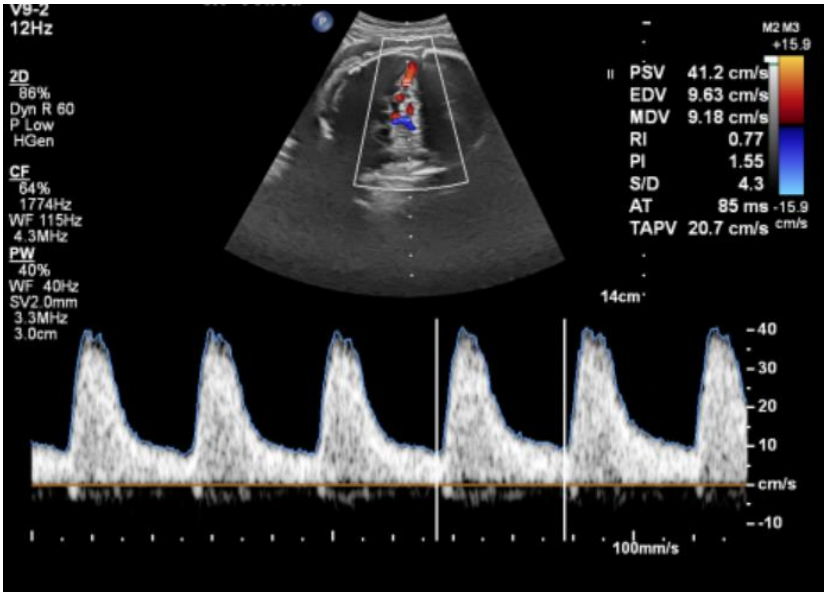

Figure 4: Normal MCA doppler waveform

DV:

It is measured at level of diaphragm reflecting status of right ventricle.

It has a biphasic pattern denoting ventricular systole, diastole followed by atrial systole. Abnormal forms are recorded in IUGR fetus. [9 17]

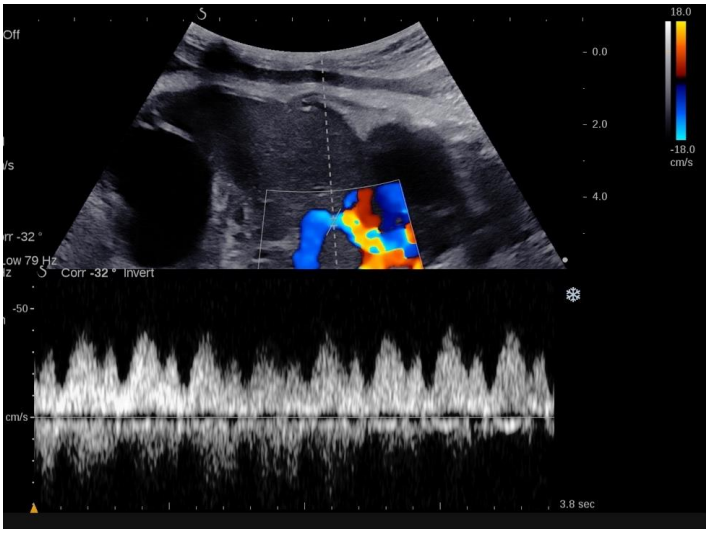

Figure 5 : Normal DV flow

Uterine artery:

It is measured just after uterine artery crosses hypogastric artery; it shows decrease in resistance as pregnancy advances due to trophoblastic invasion. Early gestation shows a notch in uterine artery doppler due to high impedance which gradually disappears as trimester advances, persistence of notch indicates abnormal doppler .[9 17 20 38]

Fetal MCA is a high resistance vessel and its S/D ratio decreases during fetal hypoxia. The CPR ratio is calculated by dividing middle cerebral artery PI (pulsatility index) and umbilical artery PI (pulsatility index)[1 18 19].

This ratio includes both maternal (placental flow) and fetal factors (MCA flow) so it is having better prognostic capability than middle cerebral artery (MCA) or umbilical artery (UA) doppler alone[4].

Th cerebroplacental ratio can be low in 3 situations –

- When MCA PI is low UA PI is normal
- when UA PI is high and MCA PI low
- when UA PI is high and MCA PI is normal [9 20 38].

Normally cerebroplacental ratio (CPR) is more than 1, but in fetal growth restriction, CPR is less than 1.

Abnormal CPR has been found to be associated with increased operative delivery, NICU admissions, low APGAR scores, low birth weight, abnormal fetal heart rate, meconium-stained amniotic fluid, still birth, neonatal death and respiratory distress [2 23 24 25 26]

The definition of abnormal CPR can be < 5^{th} centile, < 10^{th} centile and < 1 ratio[3].

EFWt is currently used to diagnose FGR and can be used in conjugation with CPR[2 21 26]

Interventions required after abnormal doppler studies depending on gestation include increased fetal surveillance by NST and weekly /biweekly doppler, termination at 38-39 weeks, termination at 34 weeks in absent flow in umbilical artery, and at 32 weeks after corticosteroid administration in reversal of flow in UA. [14]

Perinatal asphyxia

It is a major cause of death and disability in developing countries. every year 4 million people suffer from birth asphyxia leading to mental retardation, epilepsy, learning disability and cerebral palsy. Intrapartum hypoxia leads to hypoxic ischemic encephalopathy, whose underlying cause in derangement in cerebral energy metabolism. it is classified as mild moderate and severe.

Major neurodevelopmental sequalae follows severe cases of HIE. Early identification of risk factors and treating them can decrease the incidence of HIE. The antenatal risk factors encompass heavy work multiparity, poor nutrition, anemia leading to increased low birth weight. intrapartum risk factors are easily identifiable like cord prolapse; hemorrhage corrected by trained doctors. Perinatal asphyxia can lead to other long term sequalae like septicemia, hypoglycemia, necrotizing enterocolitis, myocardial dysfunction, feeding problems, immune dysregulation, hepatic and spleen dysfunction, acute renal failure, seizure disorder, visual impairment, growth hormone deficiency.[13 15]

CTG

First CTG was used in 1960s by Edward Hon, Roberto Caldeyro Barcia and Konrad Hammacher. It is an electronic machine in which FHS is heard by ultrasound transducer while maternal contractions are recorded by pressure transducer. It is recorded in a machine called external cardiotocography and traced on a paper. Other method of intrapartum FHS monitoring includes scalp electrode monitoring a form of external CTG but it requires ARM and is invasive method. Figure 6 showes the cardiotocography machine used in our labour room .

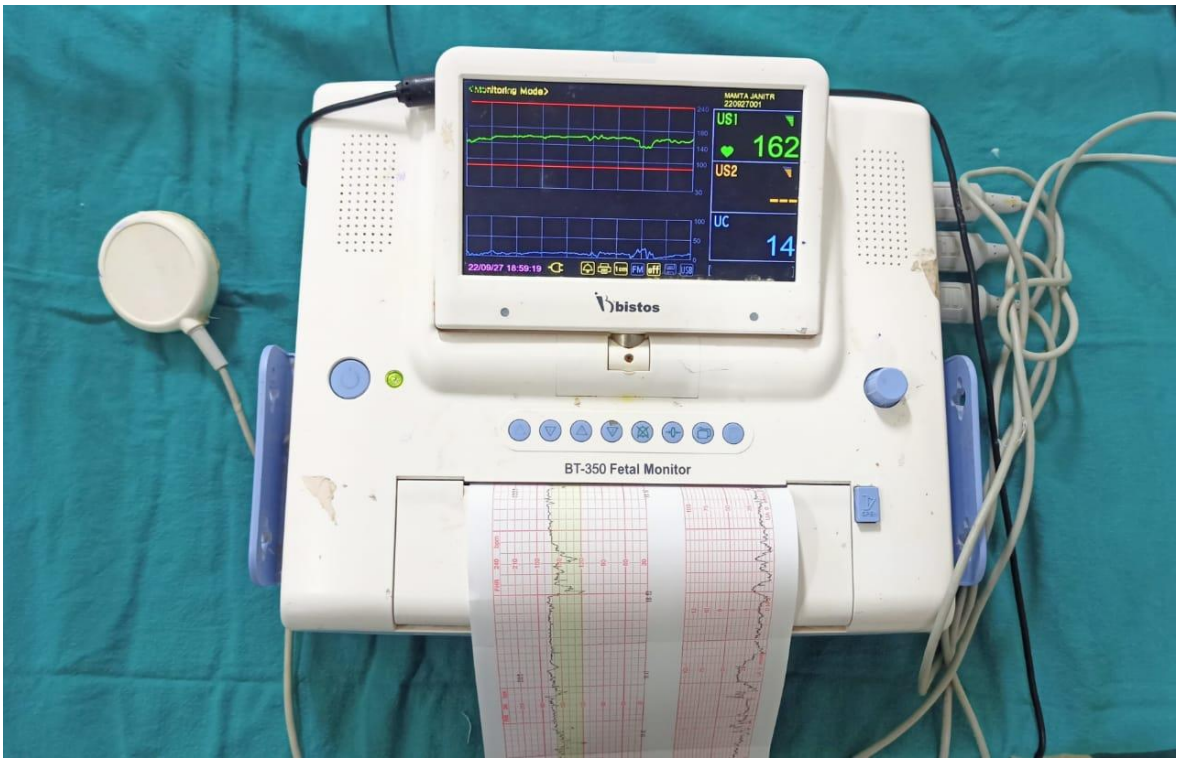

Figure 6: CTG machine bistos BT -350

CTG or electronic fetal monitoring has replaced earlier used intermittent auscultation method. As per the guidelines FHS should be heard every 30 min in first stage of labour and every 5 minutes in second stage of labour for at least 60 seconds. Some abnormal patterns of CTG are associated with cerebral palsy, but CTG has high false positive predictive value i.e., low specificity. Algorithms have been made regarding normal and abnormal status requiring intervention.

But limitations include inter and intra observer variations leading to either unnecessary intervention or false reassurances. other tests for FHS monitoring include fetal blood sample from scalp, vibroacoustic stimulation pulse oximetry, infrared spectroscopy, fetal ECG, ST segment analysis in fetal ECG, fetal stimulation tests .[14]

FGR

Screening of patients is done by clinical examination and comparing fundal height with symphysiofundal height in centimeters (>4cm difference in expected gestation and observed SFH). The specificity of this method is 96%, but it is not reliable in obese patients and with uterine fibroid. The diagnosis is confirmed by fetal biometry and ultrasound proven

estimated fetal weight <10th centile for that gestation after dating the pregnancy accurately because it can lead to false FGR.

Various risk factors of FGR are described as follows:

- **Maternal**
  - Advanced maternal age
  - Inadequate nutrition, malabsorption, and poor weight gain
  - Chronic medical diseases
    - Hypertension
      - Chronic hypertension
      - Gestational hypertension
    - Pregestational diabetes mellitus
    - Autoimmune diseases like Systemic lupus erythematosus, Antiphospholipid antibody syndrome
    - Hyperthyroidism
    - Hemoglobinopathies
    - Cyanotic cardiac disease
  - Medication exposure
    - Phenytoin
    - Valproic acid
    - Trimethadione
    - Warfarin
  - Substance abuse
- **Fetal**
  - Multiple gestation
  - Infection
    - Rubella
    - Cytomegalovirus
    - Herpes
    - Toxoplasmosis
    - Malaria
    - Syphilis
  - Anomalies
  - Chromosomal and genetic disorders
    - Trisomy 13

- Trisomy 18
- Congenital heart defects
- Gastroschisis

❖ **Placental**

- Single umbilical artery
- Abnormal cord insertion like Velamentous
- Bilobed or circumvallate placenta
- Small placenta
- Confined placental mosaicism. [17]

During the first and second trimesters of pregnancy, maternal serum markers may prove reliable indicators of foetal growth restriction [18 38 40 41 43 44]

Pregnancy-associated plasma protein-A levels below the 1st percentile (<0.29 MoM) , beta hCG levels in 1st Trimester below the 1st percentile (less than 0.21 multiples of the median), unconjugated estriol levels below the 2nd percentile (less than 0.5 multiples of the median) and in 2nd trimester elevated alpha feto protein (>2 MoM) is related to low birth weight [11].

It has been shown in previous studies that abnormal cerebroplacental ratio has a direct correlation with adverse perinatal outcomes, studies have been done on antepartum and intrapartum assessment of cerebroplacental ratio and it has shown better prediction of intrapartum fetal distress, mode of delivery and neonatal APGAR score [5].

In patients with abnormal cerebroplacental ratio, there has been increased incidence of non-reassuring fetal status, operative delivery, low birth weight and APGAR scores. We plan to assess cerebroplacental ratio in low-risk pregnant women with singleton pregnancy between 35- 37+ 6 week of gestation and its relationship with perinatal outcome.

REVIEW OF LITERATURE

Incidence of Fetal growth restriction (FGR) is about 3% to 7% of all pregnancies.[14] It is classified as early-onset FGR (<32 weeks) and late-onset FGR (≥32 weeks) based on gestational age at the time of diagnosis. The two types of fetal growth restriction (FGR) have differences in severity, natural history, doppler findings and management which is attributed to hypertensive disorders and placental findings.

Late-onset FGR is more common with a prevalence of 5%–10% it is having less severity, less commonly associated with pre-eclampsia, and mostly have normal umbilical artery Doppler. So, the diagnosis is challenging relies on changes in the cerebral circulation ("brain-sparing effect"), which is reflected by middle cerebral artery thereby a low cerebroplacental ratio.

Early-onset FGR has a prevalence of 0.5%–1%, is more severe, associated with abnormal umbilical artery Doppler and preeclampsia. The underlying placental pathology is pre-eclampsia so it is easier to detect.

Abnormal fetal growth is detected by a clinical suspicion of a decreased fundal height on inspection, followed by abdominal palpation and measuring the symphyseal-fundal height. For detecting SGA by abdominal palpation method has a sensitivity of 30% and symphysis-fundal distance has 27–86% sensitivity. Detection was improved by use of customized symphysial-fundal height charts with anthropometric characteristics and ethnicity consideration[37].

Primary tools for fetal assessment in intrauterine growth restriction (IUGR) are Biophysical profile scoring and Doppler studies. Dynamic fetal variables like tone, gross body movement, breathing movement, amniotic fluid volume (AFI) and fetal heart rate by the non-stress test (NST) are included in biophysical profile score (BPS), while doppler ultrasound describes vascular resistance in umbilical arteries and preferential blood flow to middle cerebral artery.

In previous studies most IUGR fetuses demonstrated a significant progression to decreased placental circulation (UA), brain sparing effect (MCA) and direct cardiac decompensation (DV changes) before a change in BPS (biophysical profile) [38].

In previous studies USG was done antenatally or just before admission to labour room for delivery to find out CPR in low risk cohort or SGA fetus, or high risk population and was compared to EFWt (estimated fetal weight) or CTG (continuous cardiotocography). CPR cut off were measured as centile<10^{th}, <5^{th}, value <1, <1.08 in Chainarong N, et al (2018)[1], conditional centile in Karlson et al (2016)[2] and MoM values (<0.6765MoM) in Khalil et al[5]. Perinatal outcomes were compared in all studies mainly cesarean section for fetal distress.

Other abnormal doppler findings like absent or reversal of flow in umbilical artery were also compared in some studies (Najam R et al (2016))[4].

In our study we have compared fetal distress by CTG monitoring in abnormal and normal CPR groups in labour in low risk patients (AGA fetuses) and used CPR cut of as 10^{th} centile (we have excluded early onset FGR).

Vollgraff Heidweiller et al (2021) conducted a meta-analysis according to a prospectively constructed protocol; data of 21,661 women from 17 data sets was collected to investigate if cerebroplacental ratio (CPR) adds to the predictive value of umbilical artery pulsatility index (UA PI) alone for adverse perinatal outcome in singleton pregnancies. Outcomes like perinatal death, caesarean section for fetal distress or neonatal unit admission were compared. It was observed that with UA PI alone resulted in an area under the curve (AUC) of 0.775 (95% CI 0.709–0.828) and with CPR alone in an AUC of 0.778 (95% CI 0.715–0.831) so Addition of CPR to the UA PI model resulted in an increase in the AUC of 0.003 points (0.778, 95% CI 0.714–0.831). Hence concluded that cerebroplacental ratio added no predictive value for adverse perinatal outcome beyond UA PI[39].

Flatley C, Kumar S.et al (2019) did a retrospective study on 2425 women between 36 to 38 weeks gestation (13.2 % had CPR< 10^{th} centile) to find out if the fetal cerebroplacental ratio is better that the estimated fetal weight (EFW) in predicting adverse perinatal outcomes in a low risk cohort and concluded that both CPR and EFW individually predict adverse obstetric and perinatal outcome equally and prediction rate increased when both were used in combination[3].

Fiolna M, et al (2019) had done a prospective observational study of 1902 singleton pregnancies undergoing induction of labour at ≥ 37 weeks' gestation. Doppler ultrasound was used to measure the pulsatility index (PI) in the umbilical artery (UA) and fetal middle cerebral artery (MCA) within 24 h before induction of labor. The measured UA-PI and MCA-PI and their ratio were converted to multiples of the median after adjustment for

gestational age to determine whether CPR improved the prediction of adverse perinatal outcome provided by maternal characteristics, medical history and obstetric factors. The detection rate (DR) and false-positive rate (FPR) of screening by CPR were estimated for Cesarean section for presumed fetal distress and adverse neonatal outcome, which included umbilical arterial or venous cord blood pH ≤ 7 and ≤ 7.1, respectively, 5-min Apgar score < 7, admission to the neonatal intensive care unit for > 24 h or hypoxic ischemic encephalopathy. Results identified 39% of pregnancies requiring cesarean section for fetal distress at a FPR of 10%; addition of CPR did not improve the performance of screening. In screening for adverse neonatal outcome by a combination of parity and CPR, the detection rate was 17% at a FPR of 10%. They concluded that low CPR, measured within 24 h prior to induction of labor, is associated with increased risk of Cesarean section for fetal distress and adverse neonatal outcome, but the performance of CPR for such surrogate measures of fetal hypoxic morbidity is poor[7].

Chainarong N, Petpichetchian C et al (2018) did a prospective study on 384 term pregnancies who attended the labor room during latent phase of labor and concluded that lower cerebroplacental ratio (CPR) is significantly associated with non-reassuring fetal status (p - <0.01) and cerebroplacental ratio (CPR) had low positive predictive value (PPV-23%) for predicting fetal heart rate patterns but high negative predictive value (NPV-90%) which may be used as a labor triage strategy. Fifty three percent with abnormal CPR had abnormal fetal heart rate monitoring while in normal CPR group only 28% had abnormal fetal heart rate during labor[1].

Khalil A, Thilaganathan B.et al (2017) did a study to find out the role of uteroplacental and fetal Doppler in identifying fetal growth restriction at term. They did a retrospective cohort study over a period of 14-years. The umbilical artery pulsatility index, middle cerebral artery pulsatility index, and CPR were recorded within 2 weeks of delivery and converted into multiples of median (MoM). The birthweight was converted into centiles adjusting for gestational age using reference ranges. Logistic regression analysis was performed to identify, and adjust for, potential confounders and concluded that combination of fetal weight, cerebroplacental ratio, and uterine doppler can identify fetus at risk of stillbirth. CPR MoM was significantly lower in operative delivery or admission to NICU for presumed fetal compromise (P < .01). Both CPR MoM and birth weight centile were independently associated with the risk of operative delivery for presumed fetal compromise (adjusted odds ratio [OR], 0.67; 95% confidence interval (CI-, 0.52-0.87; P =.003)[5].

Alfirevic Z et al (2017) conducted a systematic analysis to check the safety and effectiveness of continuous cardiotocography as a tool for fetal monitoring during intrapartum period , intermittent auscultation was compared with continuous CTG and came to conclusion that continuous cardiotocography had no significant improvement in perinatal death rate (risk ratio (RR) 0.86, 95% confidence interval (CI) 0.59 to 1.23, N = 33,513, 11 trials,), but was associated with having higher neonatal seizure rates (RR 0.50, 95% CI 0.31 to 0.80, N = 32,386, 9 trials,). There was no difference in cerebral palsy rates (RR 1.75, 95% CI 0.84 to 3.63, N = 13,252, 2 trials), low quality evidence). There was an increase in caesarean sections rate (RR 1.63, 95% CI 1.29 to 2.07, N = 18,861, 11 trials) and instrumental vaginal births (RR 1.15, 95% CI 1.01 to 1.33, N = 18,615, 10 trials, low quality evidence). There was no difference in the incidence of cord blood acidosis (RR 0.92, 95% CI 0.27 to 3.11, N = 2494, 2 trials) [14.]

Najam R, Gupta S et al (2016) conducted a retrospective cohort study on 150 patients (25 low risk and 125 high risk)between 28 and 40 weeks and 12% had abnormal doppler findings ,it predicted the value of cerebroplacental ratio in detection of perinatal outcome in high-risk pregnancies and concluded that CPR is having higher sensitivity and negative predictive value (NPV) in detection of IUGR (intrauterine growth restriction) , meconium aspiration syndrome (1.2% vs 43%), operative interference for fetal distress (52% vs 3.8 %) ,low APGAR detection and NICU admissions (15 % vs 63 %)in comparison to its components[4].

Karlsen HO, et al (2016) in their prospective longitudinal study on 220 pregnant women diagnosed with or at risk of having SGA fetus observed that use of conditional centiles of middle cerebral artery pulsatility index and cerebroplacental ratio < 5^{th} and < 10^{th} centiles are associated with increased risk of adverse perinatal outcomes in prediction of operative delivery due to fetal distress (p = 0.032), admission to neonatal intensive care unit (p = 0.048), as compared with the use of ≤10^{th} centile alone.

Adding conditional centile improved prediction as compared to conventional centile alone. Operative delivery due to fetal distress with CPR < 10^{th} centile was 52 % as compared to > 10^{th} centile (12%) [2.]

DeVore GR et al (2015) conducted a metanalysis of various studies to show the importance of the cerebroplacental ratio in the evaluation of fetal well-being in SGA and AGA fetuses.

The study showed that fetus with abnormal CPR that are AGA or have late onset SGA have higher incidence of fetal distress in labour requiring emergency caesarean delivery (79 vs 10.7%), increased admission rate to NICU, lower cord pH as compared to fetus with normal CPR. Fetus with early onset SGA has increased incidence of lower gestational age, lower birth weight, higher caesarean delivery for fetal distress (88.8% vs 12.5 %), lower APGAR scores, higher rate of adverse neonatal outcome and NICU admissions[9].

Prior T Mullins et al (2013) conducted a prospective observational study regarding prediction of intrapartum fetal compromise using CPR. Low risk pregnancies were recruited before active labour from 37-42 weeks and USG was done just before labour. Composite scores were calculated incorporating Umbilical Artery Pulsatility Index, Middle Cerebral Artery Pulsatility Index, Cerebral–Umbilical Ratio and Umbilical Vein Flow centile ($<10^{th}$, $10\text{-}90^{th}$, $>90^{th}$) and outcomes were compared. They concluded that fetus with a cerebroumbilical ratio $<10^{th}$ percentile were 6 times more likely to be delivered by cesarean section due to fetal distress as compared to those with a cerebroumbilical ratio $\geq 10^{th}$ percentile (odds ratio, 6.1; 95% confidence interval, 3.03−12.75).

Hence in cesarean section for fetal distress Cerebroplacental ratio$>90^{th}$ centile was protective factor (negative predictive value 100%)[6.]

Berkley E et al(2012) provided an evidence-based guidelines for utilization of Doppler studies for fetuses with intrauterine growth restriction (IUGR) by identifying Relevant documents in PubMed publications , Cochrane Library, organizational guidelines, and studies related to cerebral artery, and ductus venosus, finally concluded that using umbilical arterial Doppler among high-risk pregnancies with suspected IUGR, significantly decreases the chances of induction of labour , caesarean delivery, and perinatal deaths (1.2% vs 1.7%; relative risk, 0.71; 95% confidence interval). Antepartum Doppler of the umbilical artery should be done in suspected IUGR. Other doppler parameters like ductus venous, middle cerebral artery, and other vessels have some prognostic value only, but currently there is a lack of randomized trials so they should be reserved for research protocols[46].

Papageorghiou AT et al(2007) reviewed publications regarding Uterine artery Doppler in the prediction of adverse pregnancy outcome and it was seen that two-thirds of stillbirths that occur in the early preterm period up to 32 weeks can be predicted by uterine artery Doppler at

23 weeks. Abnormal first trimester screening which are high in second trimester also are at increased risk of fetal growth restriction. Studies which combined uterine artery Doppler with maternal serum markers have demonstrated that sensitivity of second-trimester doppler was improved by combined screening serum markers (maternal serum pregnancy-associated plasma protein A and free beta human chorionic gonadotrophin)[11]

E Hernandez-Andrade et al (2002) conducted a retrospective analysis in high risk pregnancies during 3rd trimester difference in the diagnostic capacity between the group with a uniform uterine artery score (defined as high pulsatility index>1.2 and presence of notch) and with lateral placenta (pulsatility index>1.4 on placental side >1 on non-placental site) ($p = 0.54$). It showed an increased risk for an adverse perinatal outcome with increasing uterine artery score disregarding placental location, ($p < 0.01$) with significantly increased risk for operative delivery for fetal distress, neonatal intensive care unit admission, 5-minApgar score < 7, preterm delivery and delivery of a small-for-gestational age fetus. And concluded that the uterine artery score is good tool for predicting adverse perinatal outcome[12].

A. A. Baschat et al (2001) followed the sequence of changes in Doppler and biophysical parameters as fetal growth restriction worsens by a longitudinal study in which intrauterine growth-restricted fetuses with raised umbilical artery Doppler pulsatility index (PI) > 2 standard deviations and birth weight < 10th centile was monitored by biophysical profile and concurrent Doppler examination. It was observed that worsening umbilical artery PI, advent of brain sparing and venous deterioration in (72.7%); (ii) abnormal precordial venous flows, advent of brain sparing in (13.6%); and (iii) abnormal ductus venosus only in (9.1%). In the majority cases (70.5%), doppler deterioration was 24 hours before biophysical profile score decline.[38]

Ray O. Bahado-Singh et al (1999) conducted a prospective study about cerebroplacental ratio and perinatal outcome in FGR, in which there was a statistically significant increase in perinatal morbidity and mortality in cases with an abnormal cerebroplacental ratio. For birth weight <10th percentile $p < .001$ was noted, while for birth weight <5th percentile, perinatal complications like meconium-stained fluid, cesarean section for fetal distress, 5-minute Apgar score <7, perinatal death, neonatal intensive care unit stay >24 hours, hypoglycemia, or polycythemia, birth weight <10th percentile plus complications, and birth weight <5th percentile plus complications $p < .0001$ was noted.

The cerebroplacental ratio improved the prediction of perinatal outcome as compared to umbilical artery doppler alone. But at >34 weeks pregnancy, the cerebroplacental ratio did not correlate significantly with outcome[45].

METHODOLOGY

RESEARCH QUESTION

Is there any relationship between antepartum cerebroplacental ratio and adverse perinatal outcomes?

RESEARCH HYPOTHESIS:

Null hypothesis: There is no association between antepartum cerebroplacental ratio and adverse perinatal outcomes

Alternate hypothesis: Antepartum lower cerebroplacental ratio (CPR) values are more likely to be associated with adverse perinatal outcomes.

AIM OF STUDY:

To assess the relationship between cerebroplacental ratio (CPR) and perinatal outcome in low risk pregnancy.

OBJECTIVE:

PRIMARY OBJECTIVE:

To find out the incidence of abnormal cerebroplacental ratio (CPR) in low risk pregnancy and its relationship with non-reassuring /abnormal cardiotocography (CTG) tracing during labour.

SECONDARY OBJECTIVE:

1. To compare the incidence of operative delivery due to fetal distress in low risk women with abnormal and normal cerebroplacental ratio.
2. To compare birth weight, gestational age at delivery, NICU admission, meconium-stained liquor and APGAR score at 1' and 5'in low risk women with abnormal and normal cerebroplacental ratio CPR.

MATERIALS AND METHODS:

Study Setting: This study was conducted in the Department of Obstetrics and Gynecology, AIIMS Jodhpur.

Study design: Prospective Cohort study

Study population: Women with low risk pregnancies (≥ 35 weeks) undergoing ultrasound with doppler and biometry at 35 to 37 +6 week POG and delivering at AIIMS, Jodhpur

Study Period: The study was conducted over a period of 21 months from March 2021 to November 2022

Ethical approval: 12 March, 2021 (AIIMS/IEC/2021/3320)

INCLUSION CRITERIA:

- All women of age group 18 – 35yrs with singleton pregnancy in cephalic presentation between 35 to 37 + 6 weeks POG with no major prenatally diagnosed fetal anomalies were included in the study.

EXCLUSION CRITERIA:

Women with any of the following comorbidities were excluded:

a) Women with Diabetes mellitus and hypertension
b) Fever, premature rupture of membranes
c) Chronic disease (Autoimmune disorders, Hematologic disorders, HIV, Renal insufficiency, chronic lung disease, seizure disorder on medication, thyroid disease on medication, psychiatric disorder).
d) Malpresentation
e) Multiple pregnancy
f) Planned cesarean delivery.
g) Pregnancy with diagnosed FGR (fetal growth restriction) before 35 weeks
h) Fetal demise
i) Major fetal anomalies including (Anencephaly, Spina bifida, Bilateral renal agenesis, Cystic hygroma with hydrops, Diaphragmatic hernia, Congenital heart defects).

All subjects fulfilling the above-mentioned criteria and willing to participate were approached for enrolment into the study. Patients were counselled and informed written consent was taken. The patient's baseline characteristics with history and examination were assessed like anemia, fever, routine blood pressure and GDM screening was done and other antenatal investigations were performed as per the existing protocol and according to the individual case.

Ultrasonography was performed with 5 Hz logic S8 GE pulse wave doppler at department of Diagnostic and Interventional Radiology, AIIMS. Fetal biometry, amniotic fluid index (AFI), doppler indices were recorded and cerebroplacental ratio CPR ratio was calculated.

Ultrasonography method

Ultrasonography was done to measure doppler indices, both fetal middle cerebral artery pulsatility index (MCA-PI) and umbilical artery pulsatility index (UA-PI) was measured and these were converted to cerebroplacental ratio (CPR) values. Ultrasound was performed by radiologist using proper technique and equipment (5 MHz transabdominal transducer, logiq

S8 GE pulse wave doppler) as shown in figure 7 for 3 consecutive waveforms when fetus is at rest and angle of insonation should be less than 30 degrees. Middle cerebral artery pulsatility index (MCA-PI) was measured at the origin of MCA from ICA (internal carotid artery) after identifying circle of Willis. At free loop of umbilical cord, umbilical artery pulsatility index (UA-PI) was measured.

Figure 7 : Ultrasonography machine GE logiq S8 pulse wave doppler

METHODOLOGY:

Patients were divides into two groups according to ultrasonography findings done earlier:

Group I include: CPR < 10^{th} centile

Group II include: CPR >10^{th} centile

Adverse perinatal and neonatal outcomes were compared between women with cerebroplacental ratio CPR <10^{th} centile and those with cerebroplacental ratio CPR > 10^{th} centile

All women were followed till delivery and following perinatal outcomes were observed:

- Gestational age at delivery
- Non reassuring/ abnormal fetal CTG (cardiotocography) tracing during labour using Bistos BT350 CTG machine
- Patient undergoing Cesarean section or operative vaginal delivery due to fetal distress
- Meconium-stained amniotic fluid
- Birth weight
- APGAR score at 1' and 5'
- NICU admission

Reassuring CTG (cardiotocography) tracing was defined as:

- **Base line FHR**- 110 to160
- **Variability** – 5 to 25 minutes
- **Deceleration-** none or Variable decelerations with no concerning characteristics* for less than 90 minutes

Non reassuring CTG (cardiotocography) tracings during labour were characterized by:

- **Base line FHR**- 100 to109 or 161to 180
- **Variability** - Less than 5 for 30 to 50 minutes or more than 25 for 15 to 25minutes
- **Deceleration** –

a. Variable decelerations with no concerning characteristics* for 90minutes or more or
b. Variable decelerations with any concerning characteristics* in up to 50% of contractions for 30 minutes or more or
c. Variable decelerations with any concerning characteristics*in over 50% of contractions for less than 30 minutes or

d. Late decelerations in over 50% of contractions for less than 30 minutes, with no maternal or fetal clinical risk factors such as vaginal bleeding or significant meconium

Abnormal CTG tracing was defined as:

- **Base line FHR-** below 100 or above 180
- **Variability** - Less than 5 for more than 50 minutes or more than 25 for more than 25minutes or Sinusoidal
- **Deceleration** –

a. Variable decelerations with any concerning characteristics* in over 50% of contractions for 30 minutes or
b. Late decelerations for 30 minutes or
c. Acute bradycardia, or a single prolonged deceleration lasting 3 minutes or more

*Regard the following as concerning characteristics of variable decelerations: lasting more than 60 seconds; reduced baseline variability within the deceleration; failure to return to baseline; biphasic (W) shape; no shouldering.

(According to NICE guidelines 2017[8])

The attending obstetricians in labour room were blinded with doppler findings unless diagnosed as FGR which was managed as high risk.

Various CTG tracings of patients are shown in the figures 8-12

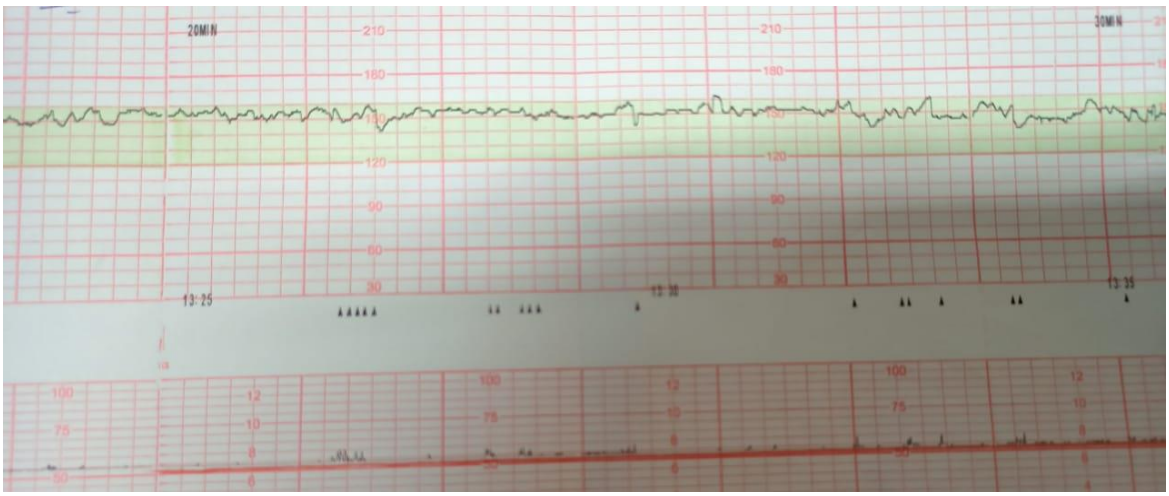

Figure 8: Reassuring CTG tracing

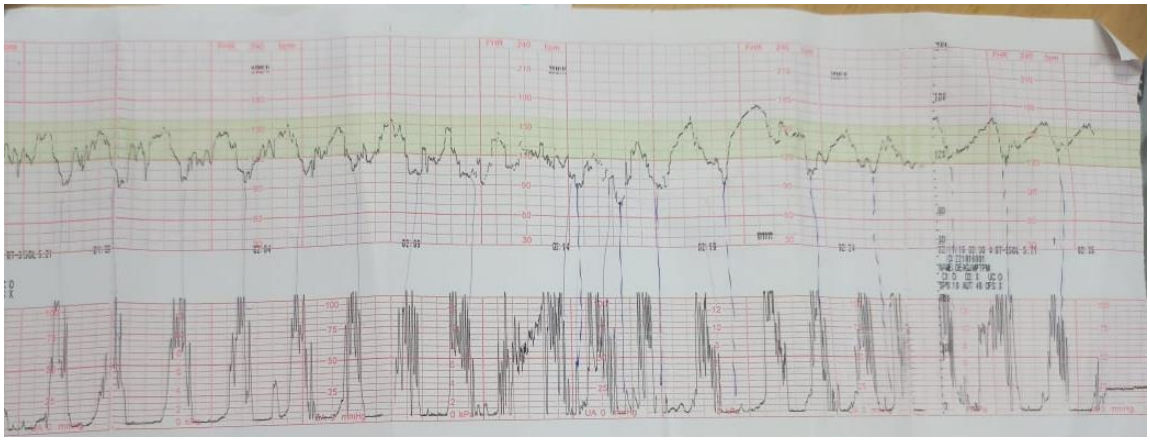

Figure 9 : Abnormal CTG tracing

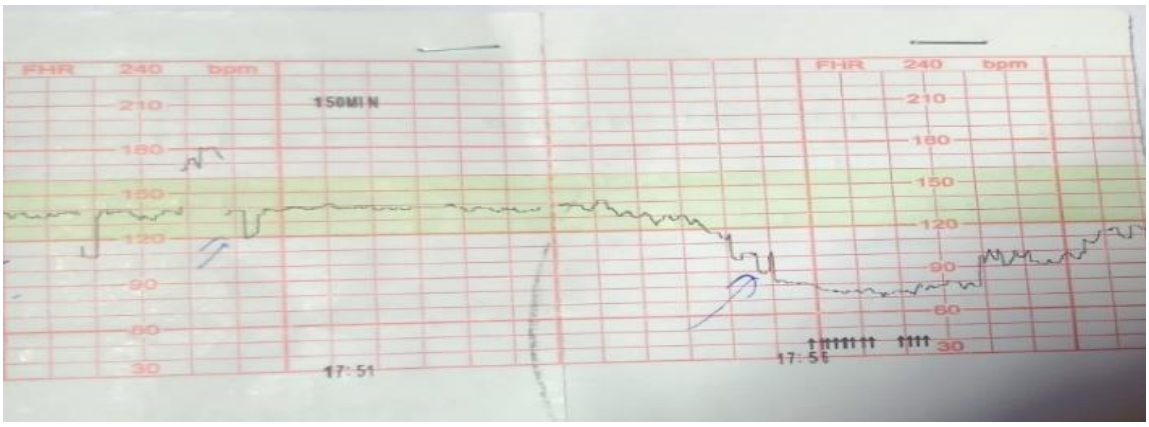

Figure 10: Abnormal CTG tracing 2

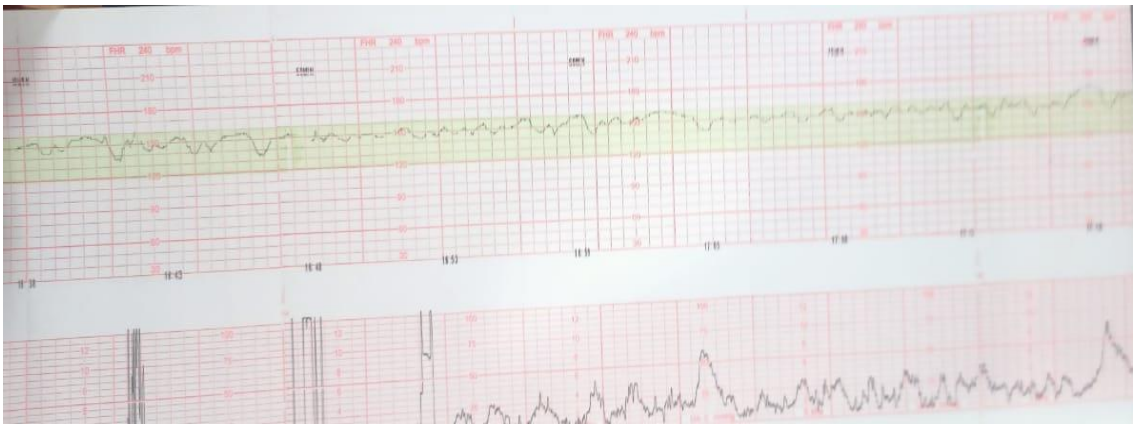

Figure 11 : Non reassuring CTG tracing

Figure 12: Non reassuring CTG tracing 2

SAMPLE SIZE:

Expected incidence of abnormal CPR in low risk pregnancy is ~15% [(**13.2%[3]) Flatley C et al (2019) and 19.8%[7] Fiolna M et al (2019)]**. Sample size for the study is calculated as:

$$m=\frac{Z^2 (1- \alpha/2) P(1-P)}{d^2}$$

d= 20% of 15 %= 0.03

$$= \frac{(1.96)^2 (0.15) (0.85)}{(0.03)^2}$$

$$n= \frac{m}{1+(m-1)/N}$$

$$=\frac{544}{1+543/250}$$

=172

With above calculations sample size would be 172 including attrition.

STATISTICAL ANALYSIS:

The quantitative variables were compared between the two groups by using independent t test and if the data do not follow normal distribution, then non parametric test Mann Whiteny U test was used for comparison. The qualitative data was compared by using Chi-square test. P < 0.05 was considered as statistically significant. Data was also presented by using various charts and analysis was done using SPSS version 23.0.

Level of significance "p" is the probability signifies level of significance. The mentioned p in the text indicates the following:

$p > 0.05$ Not significant

$p<0.05$ significant

$p<0.01$ highly significant

Ethical consideration

The following study was conducted after approval from the Institutional Ethics Committee (Ethical approval No-AIIMS/IEC/2021/3320). Informed consent was taken from all women being enrolled for the study by providing them a proper printed consent form along with patient information sheet and after properly explaining the purpose of the study.

OBSERVATION AND RESULTS

During the study period, a total 210 patients were approached for enrollment 15 patients were diagnosed to have early onset FGR, 5 patients had preterm premature rupture ofmembranes (PPROM), 5 patients had diabetes mellitus, 8 had planned cesarean delivery and5 patients were preeclamptic, therefore 172 women were finally included in analysis, out of which 55 women had low CPR (<10^{th} centile) and 117 women had normal CPR (>10^{th} centile).

These patients were followed up till delivery and 94 had normal vaginal delivery, 72 had cesarean section while 6 had operative vaginal delivery.

DEMOGRAPHIC VARIABLES

We compared the demographic variables in two groups in terms of age, education, occupation, socioeconomic status, residential status and gestational age at USG.

The demographic profile of patients in the two groups are depicted in table 1.

Table 1 Baseline characteristics of patients in the two groups

Variable	Group I (<10^{th} Centile) Mean +/-SD	Group II (>10^{th} Centile) Mean +/-SD	p value
Mean Age	25.64+/-3.5	26.62+/-4.05	0.126
Gestational age at USG	35.98+/-0.93	36.08+/-0.93	0.503
Education (Graduate)*	19(34.54%)	37(31.6%)	0.76
Occupation (Housewife)*	41(74.54%)	92(78.63%)	0.8
Socioeconomic status (Lower middle class) *	34(61.8%)	86(73.5%)	0.37
Residential status (urban)*	23(41.8%)	45(38.46%)	0.6
Gestational age at delivery	38.18+/-1.27	38.49+/-1.38	0.536

*N(%)

Used t test

Used Chi square test

P<0.05 – statistically significant

1. Age – The patients included in the study were between 18-40 years age group. Mean age of patients in the study was 26.3+/-3.9 years. Table 3 shows the distribution of patients according to age in the study population.

Table 2 shows mean age of patients in <10th centile group (25.64+/-3.5years) and >10th centile group (26.62+/-4.05years). The subjects in two groups were comparable in terms of age (p value – 0.126).

Table 2: Comparison of mean age of patients in two groups

Variable	**Group I (<10th Centile)**	**Group II (>10th Centile)**
Age (years)	25.64+/-3.5	26.62+/-4.05

Data expressed as Mean ±SD

Used independent t test p value < 0.05 is significant

Table 3: Distribution of age in two groups

Used Chi square test

	Group I (<10th Centile) N=55(%)	**Group II (>10th Centile) N=117(%)**	**p value**
<20 years	3(5.4%)	4(3.41%)	0.126
20 – 25 years	26(47.3%)	46(39.31%)	
25 – 30 years	21(38.1%)	46(39.31%)	
30 – 35 years	5(9.09%)	18(15.38%)	
> 35 years	0	3(2.5%)	

P<0.05 – significant

Figure 13 and 14 shows age groups compared in the study population in the two groups. Age has symmetric distribution depicted by bell shaped curve

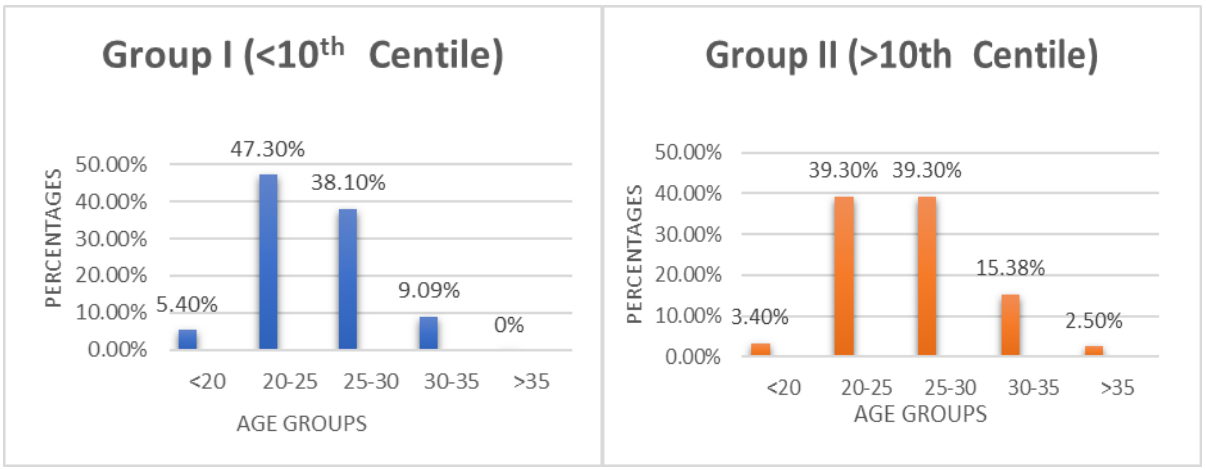

Figure 13: Distribution of patients according to age in the study population

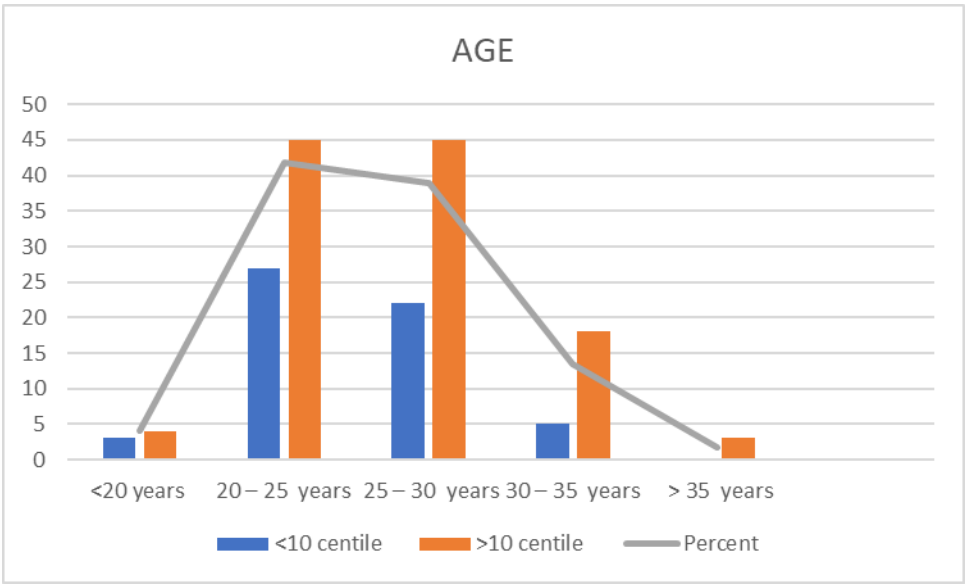

Figure 14: Bar chart showing distribution of patients according to age

It is a bell-shaped curve

2. Education: The majority of patients were graduates or senior secondary in both the groups 34.5% in <10th centile and 31.6 % in >10th centile group (graduate) (p value- 0.76)

as depicted in Table 4 and Figure 15, 16 shows the distribution of the patients according to education in the study population.

Table 4: Distribution of the patients according to education in the study population.

Education	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
Graduate	19(34.54%)	37(31.6%)	0.76
Higher	3(5.45%)	9(7.69%)	
Senior secondary	19(34.54%)	36(30.76%)	
Middle school	9(16.36%)	20(17.09%)	
Primary	5(9.09%)	15(12.8%)	

Used Chi square test

P<0.05 – significant

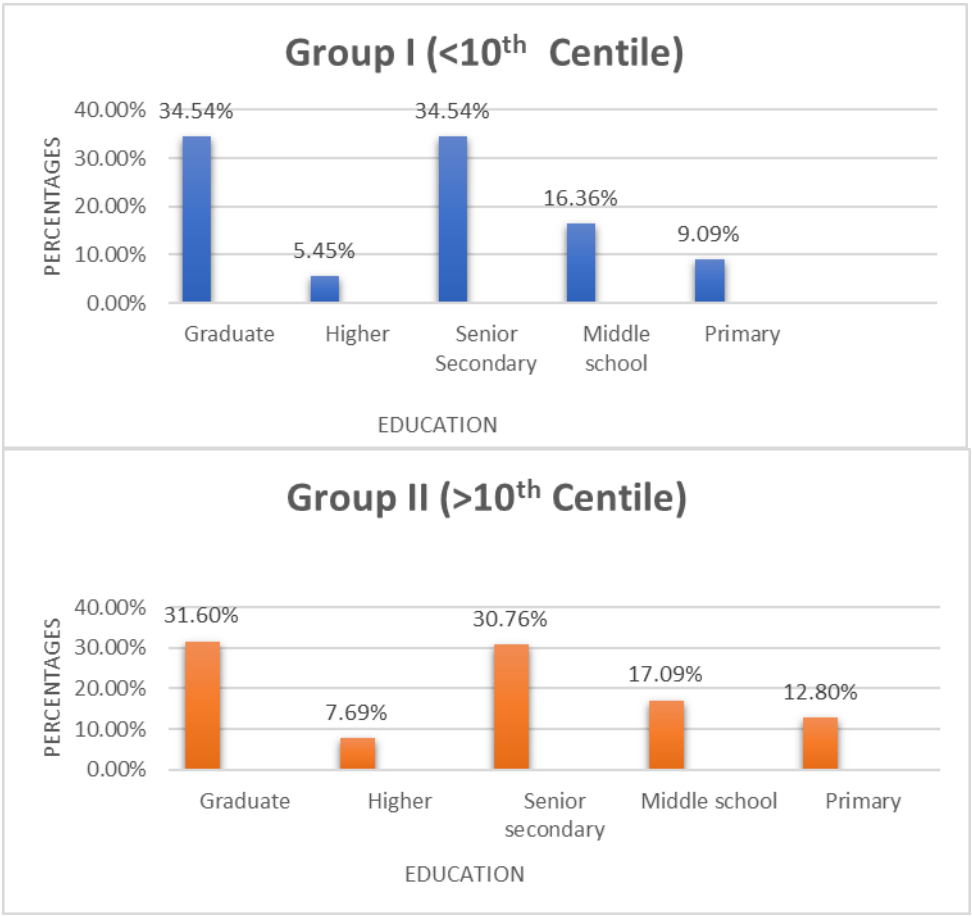

Figure15: Distribution of the patients according to education in the study population

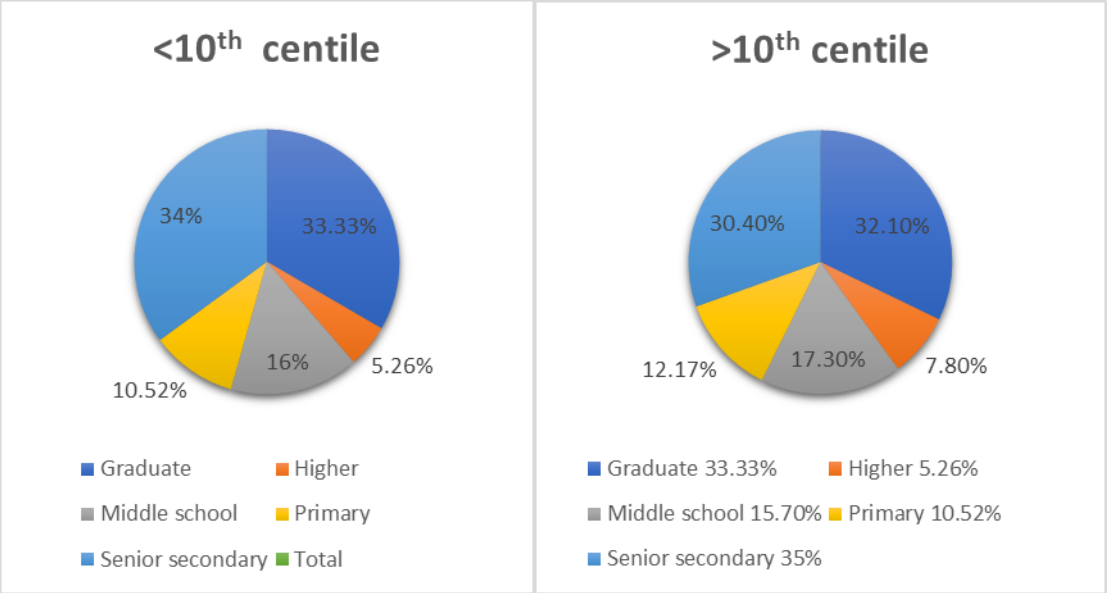

Figure 16: Pie chart showing distribution of the patients according to education in the study population

3. Occupation-Majority of the patients in both groups were housewives 74 % in <10th centile and 78 % in >10th centile. Desk job included Bank Employee, Advocate, hotel management medical and paramedical worker, student, engineer and Field jobs included Handicraft workers, Saleswomen and Daily wager (p-0.8).

Table 5 and Figure 17 show the distribution of patients according to occupation in the study population.

Table 5: Distribution of the patients according to occupation in the study population

Occupation	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
Housewife	41(74.54%)	92(78.63%)	0.8
Student	1(1.8%)	2(1.7%)	
Doctor /nurse/paramedical	2(3.63%)	4(3.41%)	
Laborer	1(1.8%)	0	
Teacher	4(7.27)	8(6.83%)	
Engineer	1(1.8%)	4(3.41%)	
Others	5(9.09%)	7(5.98%)	

Used Chi square test

P<0.05 – significant

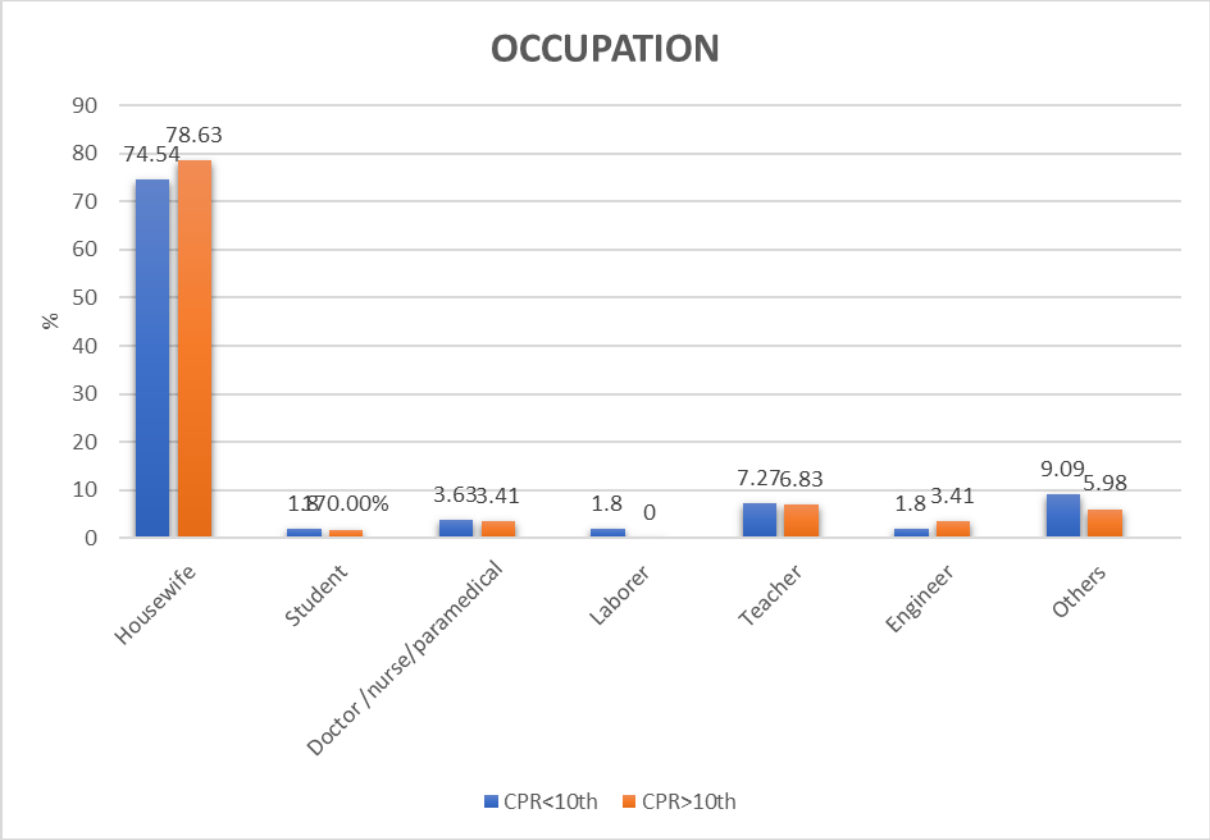

Figure 17: Distribution of the patients according to occupation in the study population

4. Socioeconomic status : According to modified Kuppuswamy scale As seen in Table 6 and figure 18 , the majority of the subjects were from the lower middle background; 34(61 %) in <10th centile and 86 (73 %) in >10th centile , however, there was no statistically significant difference between the two groups. (p-0.37)

Table 6 : Distribution of the patients according to socioeconomic status in the study population

Socioeconomic status	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
Upper Middle class	9(16.36%)	19(16.2%)	0.37
Lower Middle class	34(61.8%)	86(73.5%)	
Upper lower class	12(21.8%)	12(10.25%)	

Used Chi square test

P<0.05 – significant

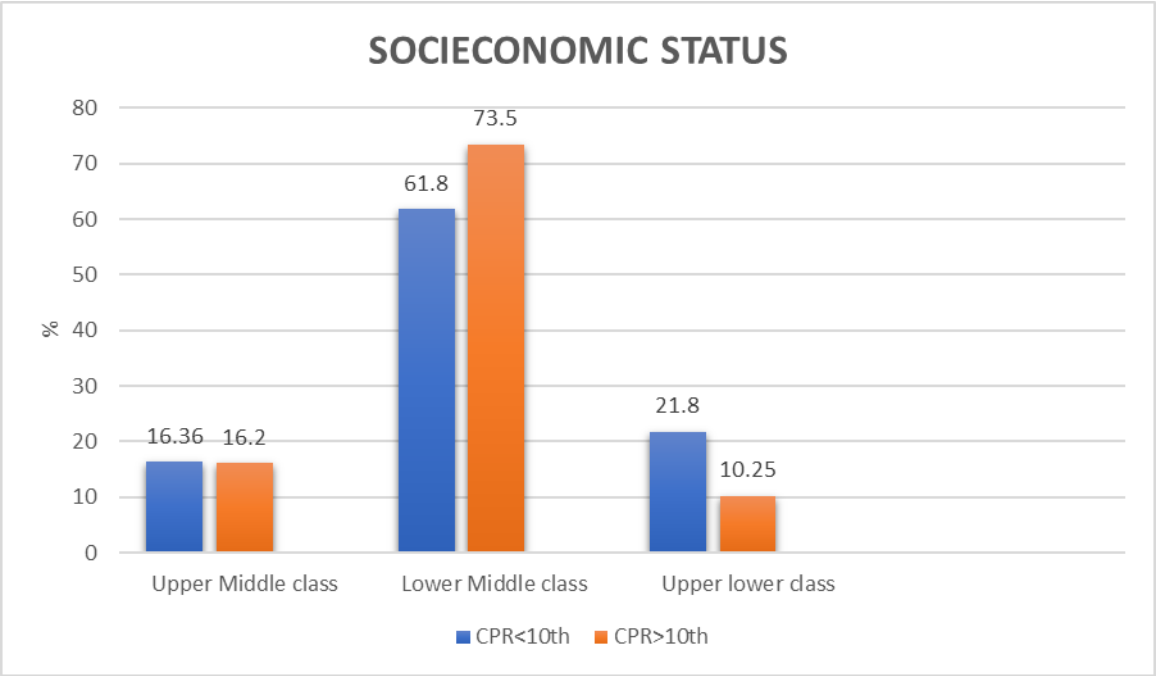

Figure 18: Distribution of the patients according to socioeconomic status in the study population

5. Residential status: As seen in Table 7 and figure 19, the majority of the subjects were from the urban background; 23 (41%) in <10th centile and 45 (38 %) >10th centile group. This distribution was comparable in both the groups, however, not statistically significant (p-0.6)

Table 7: Distribution of Study groups by Residential status

Residence	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
Urban	23(41.8%)	45(38.46%)	0.6
Semiurban	13(23.63%)	36(30.76%)	
Rural	19(34.54%)	36(30.76%)	

Used Chi square test

P<0.05 – significant

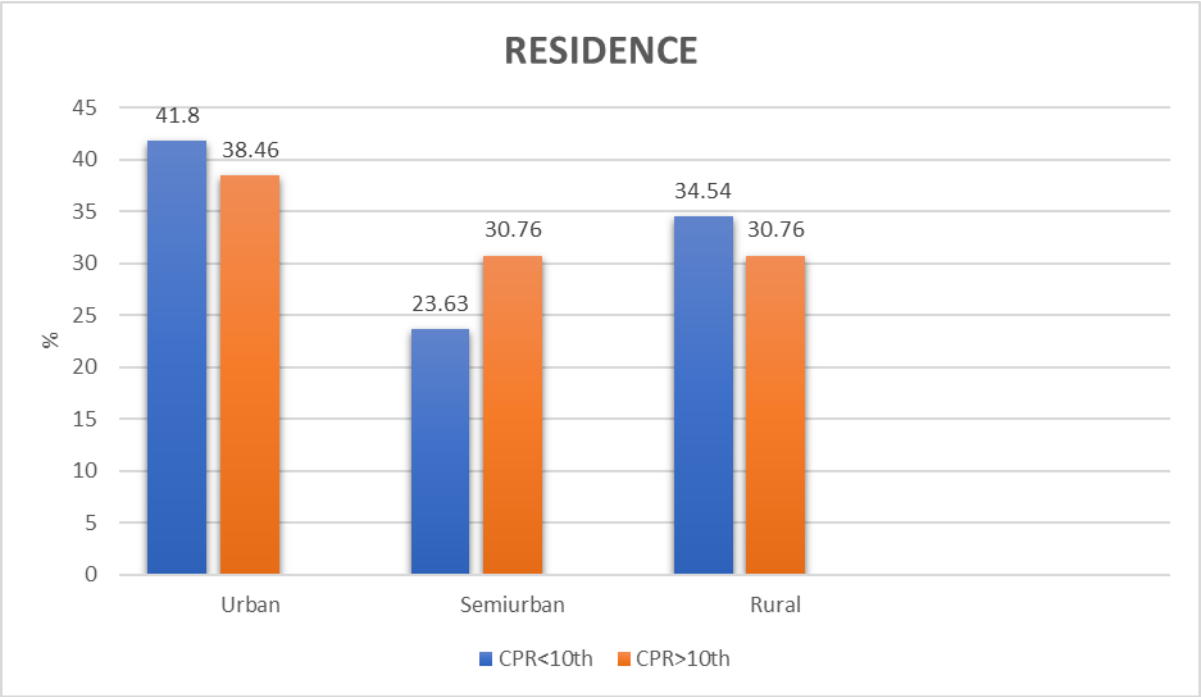

Figure 19: Distribution of Study groups by Residential status

6. Gestational age at USG

Out of 172 women, 28 (50.9%) women had gestational age between 35-35+6 week in group I and 50(42.73%) in group II. Both the groups were comparable in terms of gestational age at the time of USG (p=0.503) as depicted by table 8 and figure 20.

Table 8: Distribution of study groups by gestational age at USG

POG in weeks at the time of USG	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
35-35+6	28(50.9%)	50(42.73%)	0.503
36-36+6	14(25.45%)	30(25.64%)	
37-37+6	13(23.63%)	37(31.62%)	
Median	35.89	36 .03	
Mean±SD	35.98+/-0.93	36.08+/-0.93	

Used independent t test p<0.05 as significant.

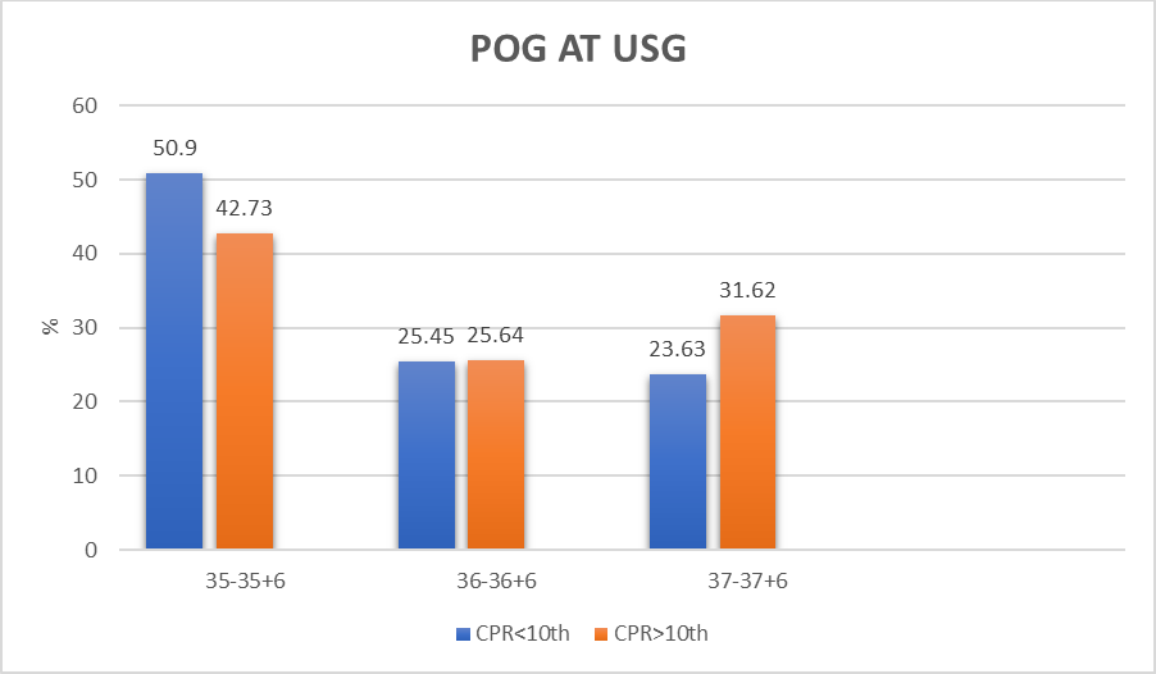

Figure 20: Distribution of study groups by gestational age at USG

PRIMARY OUTCOME:

CPR was abnormal in 55(31.9%) patients and normal in 117(68.02 %) patients.

Thus, the incidence of abnormal cerebroplacental ratio (CPR) in low risk pregnancy is 31.9%.

Table 9: Distribution of the patients according to CTG tracing in the study population

	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
Reassuring	34(61.81)	95(81.19)	0.173
Non reassuring	10(18.18)	13(11.11)	0.245
Abnormal	11(20)	9(7.69)	0.027

Used Chi square test, p value < 0.05 is significant

As described in Table 9 and figure 21, CTG evaluation during labour showed that 61.81% women with abnormal CPR (<10th centile) had reassuring pattern as compared to 81.19% women with normal CPR (>10th centile) p value 0.173.

Non reassuring CTG tracing was higher in abnormal CPR group I (p- 0.245)

Significantly higher number of women with abnormal CPR had abnormal CTG pattern 11(20%) as compared to women with normal CPR 9 (7.69%) (p- 0.027)

One patient had CPR<1 centile had IUD later on delivered vaginally while one patient with normal CPR (81 centile) also had IUD.

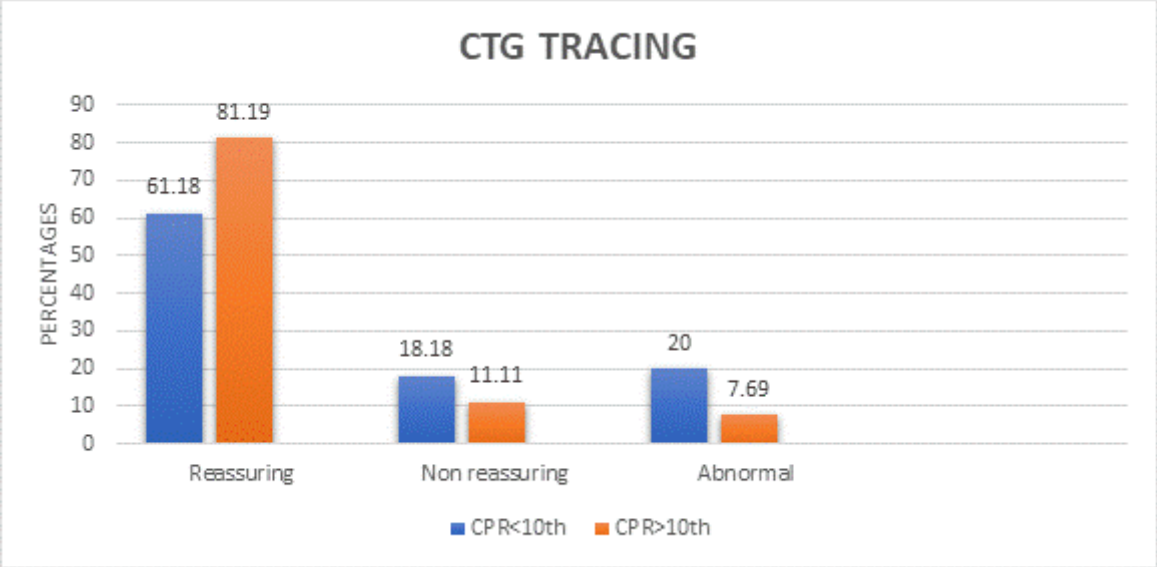

Figure 21: **Distribution of the patients according to CTG tracing in the studypopulation**

Odds ratio of CPR <10th centile for non-reassuring and abnormal CTG is 2.61

Positive predictive value of CPR<10th centile in predicting Abnormal and non reassuring fetalstatus during labor is 20% and 18.18 % respectively, while negative predictive value is higher(81.19 %). Positive likelihood ratio of CPR <10th centile is 1.852 as shown in table 10

Table 10: PPV, NPV and OR of CPR <10th centile for CTG tracing

	CPR<10th centile for fetal distress	
PPV	Abnormal CTG tracing	Non Reassuring CTG tracing
	20 %	18.18%
NPV	81.19%	
Odds ratio	2.61	

Various primary and secondary outcomes of our study is described in table 11

Table 11 : Comparison of study outcomes in both groups

Variable	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
PRIMARY OUTCOME			
Normal CTG tracings	34(61.81)	95(81.19)	0.173
Non reassuring CTG tracings	10(18.18)	13(11.11)	0.245
Abnormal CTG tracings	11(20)	9(7.69)	0.027
SECONDARY OUTCOMES			
Normal delivery rate	27(49.09)	67(57.26)	0.47
Caesarean section rate	25(45.45)	47(40.17)	0.63
Operative vaginal delivery rate	3(5.45)	3(2.56)	0.33
Caesarean section due to fetal distress	10(40)	14(29.78)	0.38
APGAR at 5' </=7	3(5.45)	6(5.12)	0.94
Mean Birth weight *	2587+/-454	2873+/-431	<0.0001
Meconium stained liquor	4(7.27)	10(8.54)	0.77
NICU admission	2 (3.63)	5(4.27)	0.87

*mean +/- SD

SECONDARY OUTCOMES:

1.Mode of delivery: Caesarean and operative vaginal delivery rates were (45.45%), (5.45%) in abnormal CPR group I while (42.73 %), (2.56%) in normal CPR group II respectively (p=0.63, 0.33). Normal delivery was higher in normal CPR group II (57.26 %) while (49.09%) in low CPR group I but no significant difference was seen as described in table 12 and figure22

Table 12: Distribution of the patients according to mode of delivery in the study population

	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
Normal delivery	27(49.09)	67(57.26)	0.47
Cesarean section	25(45.45)	47(40.17)	0.63
Operative vaginal delivery	3(5.45)	3(2.56)	0.33

Used Chi Square test, p value < 0.05 is significant

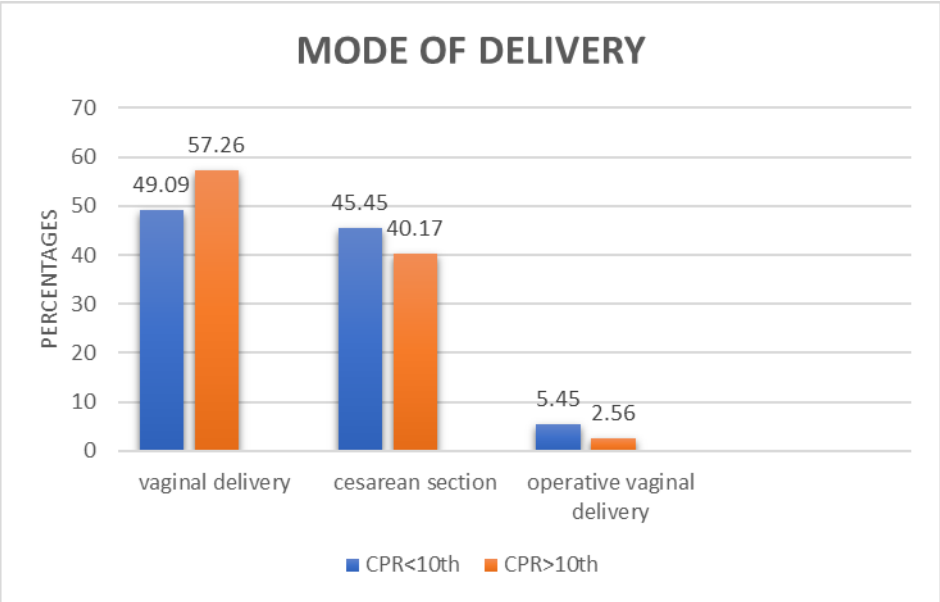

Figure 22 : Distribution of the patients according to mode of delivery in the study population

Out of 172 cases: 94 had normal vaginal delivery, 72 delivered by cesarean section while 6 had operative vaginal delivery (instrumental vaginal delivery)

Out of 72 cesarean deliveries, in 24(33.33%) patients indication of cesarean was fetal distress defined as abnormal or non-reassuring CTG tracing with MSL /IUGR /anhydramnios. According to table 13 the rate of cesarean section due to fetal distress was higher and found in 40% in women with abnormal CPR as compared to 29.78% in women with normal CPR (p- 0.38).

Table 13: Comparing cesarean section due to fetal distress in both groups

Mode of delivery	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
Cesarean section due to fetal distress	10(40)	14(29.78)	0.38

Used Chi Square test, p value < 0.05 is significant

2. APGAR scores:

APGAR score was given by pediatrician at 1 and 5 minute of life (70.9 %) of low CPR had APGAR at 1 minute of 8-9, while (84.34 %) of normal CPR had this APGAR, low APGAR (</=7) was observed in 39 patients which mostly belonged to abnormal CPR group I (29.09%) p value- 0.229 as seen in table 14 and figure 23.

- **APGAR at 1 minute:**

  It reflects any acute fetal distress during delivery

Table 14: Distribution of the patients according to APGAR at 1 minute in the study population

	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
8-9	39(70.9)	94(84.34)	0.51
</=7	16 (29.09)	23(19.65)	0.229

Used Chi Square test, p value < 0.05 is significant

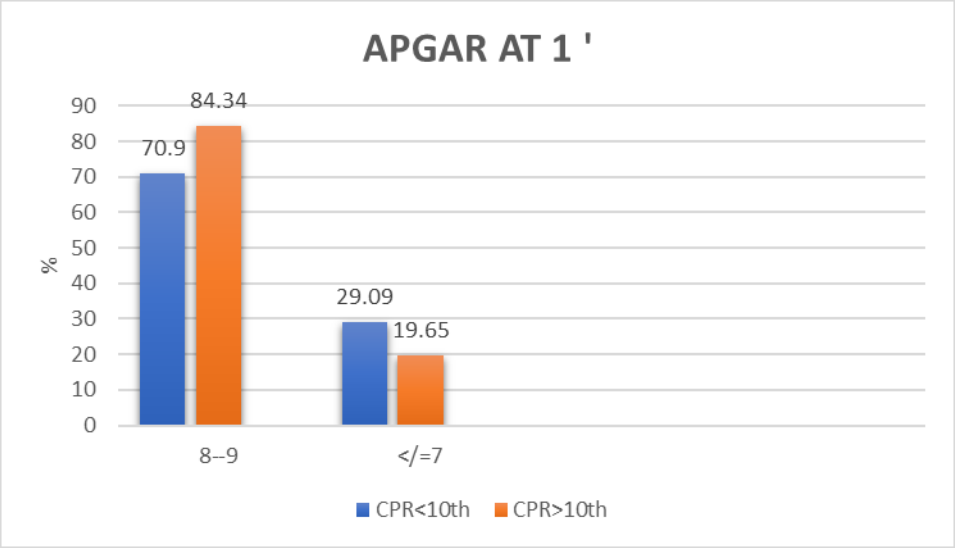

Figure 23: Distribution of the patients according to APGAR at 1' minute in the study population

- **APGAR 5 minutes**

  Denotes chronic insult to the fetus if poor APGAR scores.

  An APGAR score of 8-9 or </=7 was found equally in both CPR groups (94.5%), and (5%) respectively (p value =0.9) as shown in table 15 and figure 24

Table 15: Distribution of the patients according to APGAR at 5 minutes in the study population

	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
8-9	52(94.54)	111(94.87)	0.98
</=7	3(5.45)	6(5.12)	0.94

Used Chi Square test, p value < 0.05 is significant

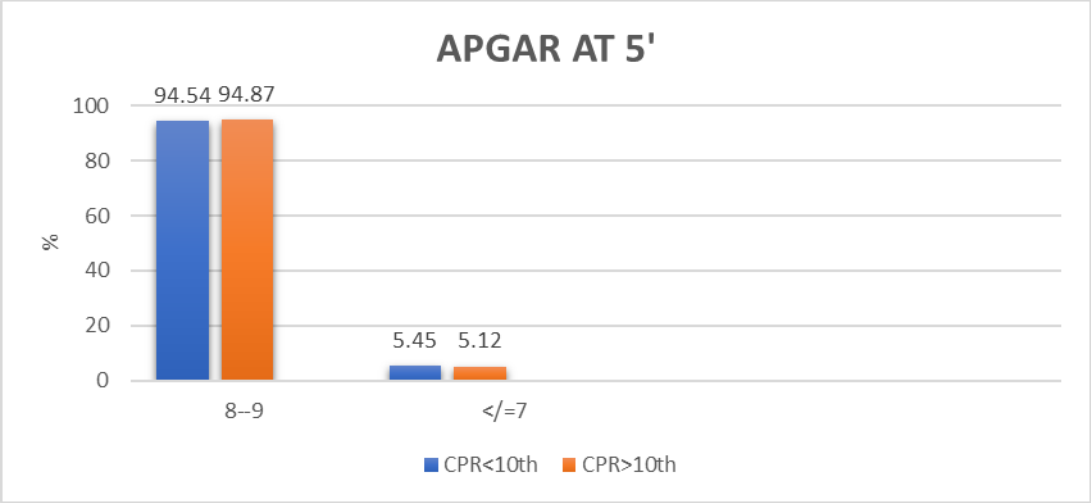

Figure 24: Distribution of the patients according to APGAR at 5' minute in the study population

3. Birth Weight:

It was classified in 2 groups of >2.5 Kg and low birth weight < 2 .5Kgs. In our study we had upper and lower extremes of birth weight to be 1340 gm and 4210 gm respectively.

Seventy one percent babies had birth weight >2.5 kg while 29% had low birth weight.

In normal CPR group II 92 (78.6%) had normal birth weight only (21.3%) had low birth weight

(p value 0.08). In abnormal CPR group I, (54.5%) babies had normal birth weight and (45.45%) were born low birth weight (p -0.006) which is quite significant.

Table 16 and figure 25 describes birth weight distribution in both groups while figure 26 describes mean birth weight in both groups which had a significant difference (p-0.0001)

Table 16: Distribution of the patients according to birth weight of baby in the study population

	Group I (<10th Centile) N=55(%)	**Group II (>10th Centile) N=117(%)**	**p value**
>2.5 Kg	30(54.54)	92(78.63)	0.08
<2.5 Kg	25(45.45)	25(21.36)	0.006
***Mean +/- SD**	2587+/-454	2873+/-431	<0.0001

Used Chi Square test, p value < 0.05 is significant

*Used independent t test p value < 0.05 is significant

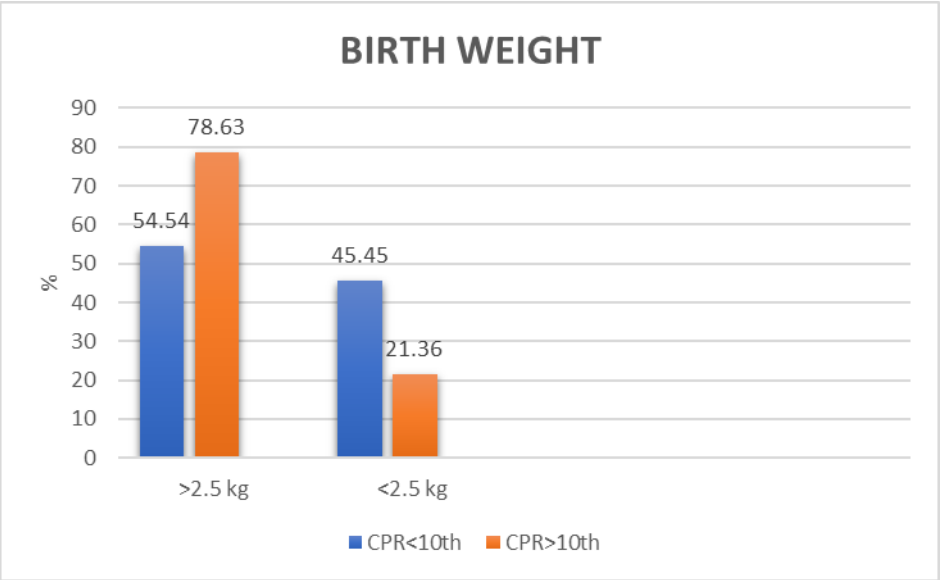

Figure 25 : Distribution of the patients according to birth weight groups in the study population

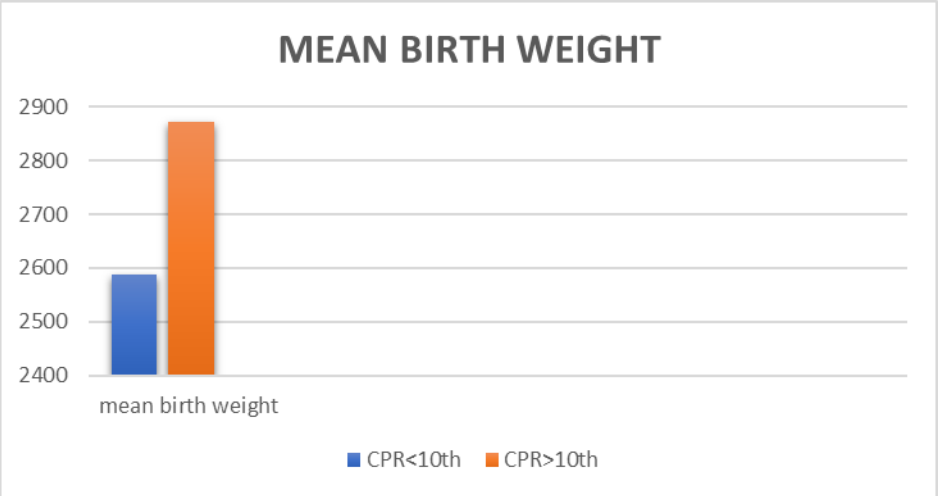

Figure 26 : Mean birth weight compared in two study groups

4.Meconium staining:

Only (8.14%) cases had meconium staining out of which (7.27 %) were in low CPR group while (8.54 %) in normal CPR group (p value – 0.77). One baby developed respiratory distress and was intubated had meconium-stained liquor, delivered by operative vaginal delivery.

Table 17 and figure 27 describes distribution of patients according to meconium staining in study groups.

Table 17: Distribution of the patients according to amniotic fluid in the study population

	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
Clear	51(92.72)	107(91.45)	0.93
Meconium stained	4(7.27)	10(8.54)	0.77

Used Chi Square test, p value < 0.05 is significant

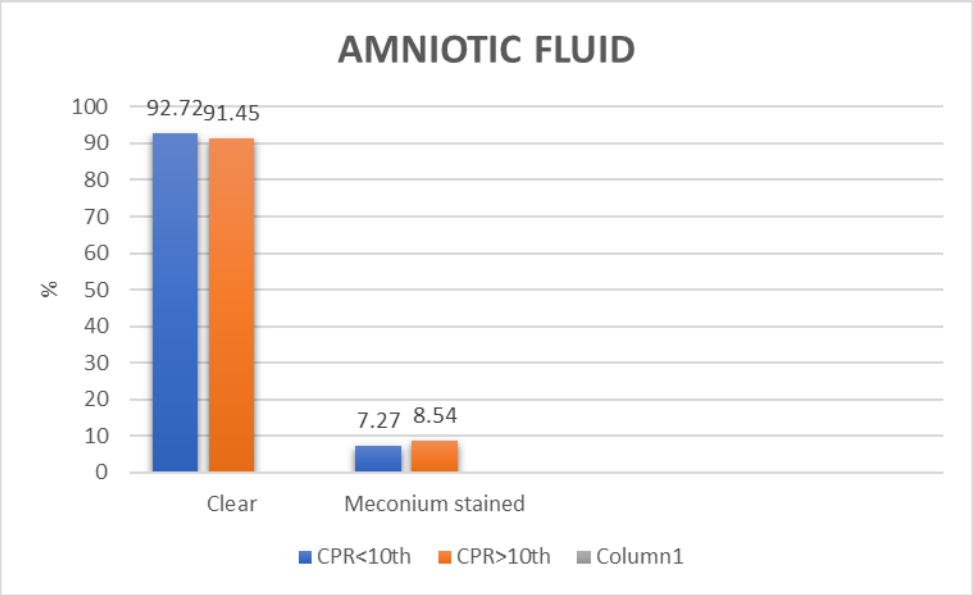

Figure 27: Distribution of the patients according to amniotic fluid in the study population

5. NICU admission:

NICU admissions were more in normal CPR group I (4.27 %) as compared to abnormal CPR group II (3.63 %). But it was not significant (p-0.87)

2 babies were given CPAP, while one was given PPV and intubated, while one child had Downs's syndrome and was kept in NICU for respiratory distress. All babies were shifted motherside later on. Table 18 and figure 28 shows NICU admission in the two groups

Table 18: Distribution of the patients according to NICU admission in the study population

	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
NO	53(96.36)	112(95.72)	0.97
Yes	2(3.63)	5(4.27)	0.87

Used Chi Square test, p value < 0.05 is significant

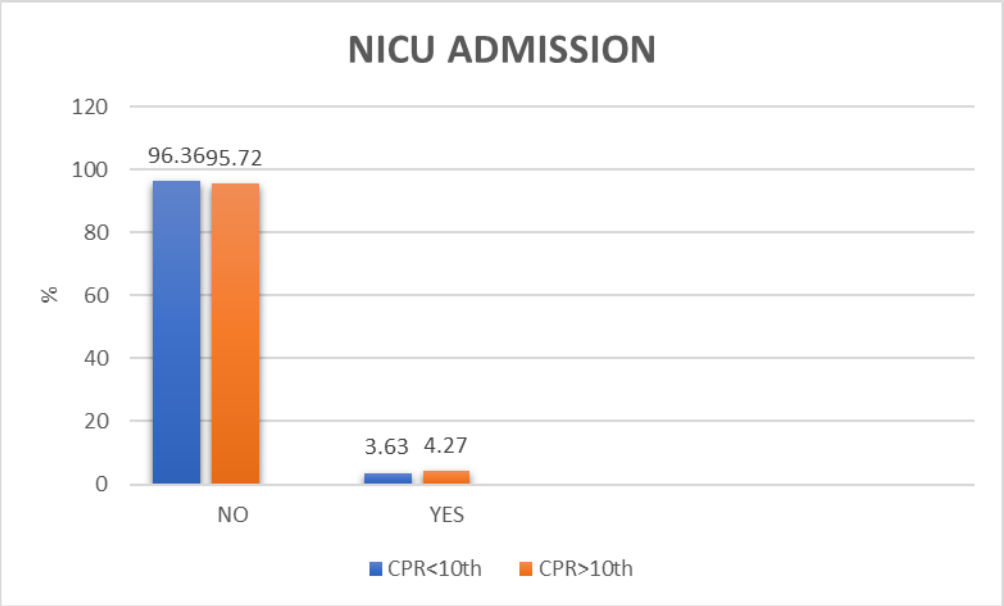

Figure 28 : Distribution of the patients according to NICU admission in the study population

7. POG at delivery

Mostly patients delivered at 37-38+6 weeks (56.36%), about 70 (40%) delivered at >39 weeks. Only 8 deliveries were preterm which were equally divided in both the groups 4(7.27%) and 4(3.4%) respectively in group I and II which is shown in table 19 and figure 29.

Table 19: Distribution of the patients according to period of gestation at delivery in the study population

Gestational age at delivery	Group I (<10th Centile) N=55(%)	Group II (>10th Centile) N=117(%)	p value
35-36+6 weeks	4(7.27)	4(3.4)	0.29
37-38+6 weeks	31(56.36)	63(53.84)	0.84
>39 weeks	20(36.36)	50(42.73)	0.53
Mean+/-SD	38.18+/-1.27	38.49+/-1.38	0.536

Used independent t test, p value < 0.05 is significant

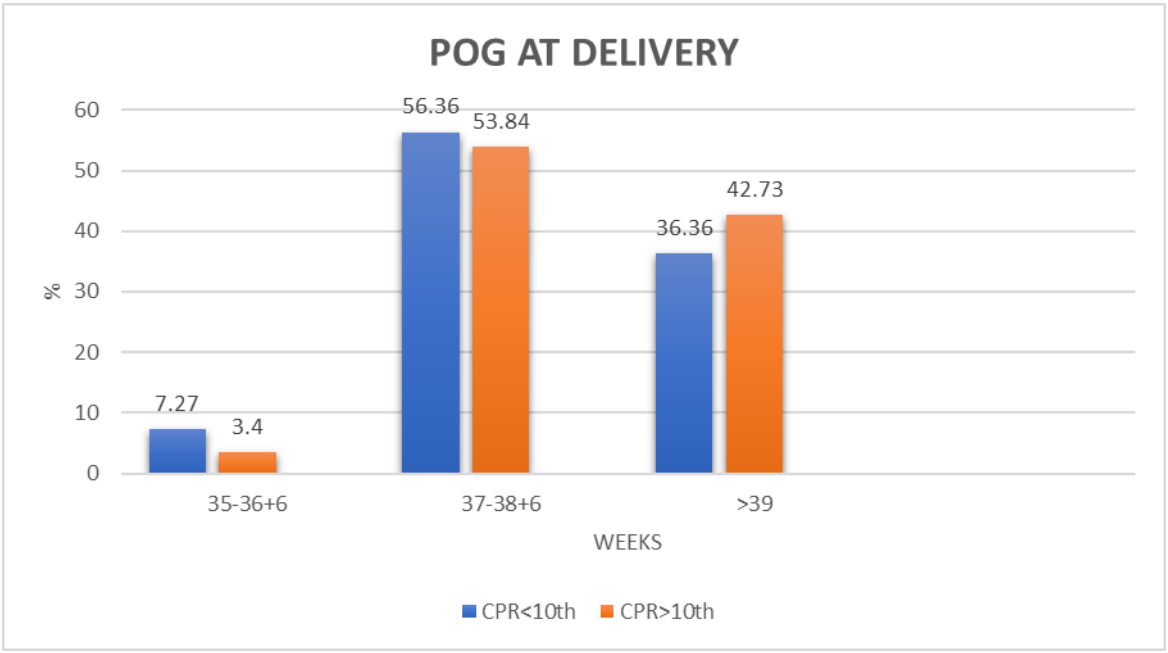

Figure 29: Distribution of the patients according to period of gestation at delivery in the study population

DISCUSSION

The first use of Doppler ultrasound of umbilical artery waveform patterns during pregnancy was reported in 1977 from Dublin. The cerebroplacental ratio (CPR), which was first reported by Arbeille et al [39] in 1987.But it is not implemented for use in regular day to day practice .It is a gestational age dependent marker, normally it should be >1 , while abnormal CPR (<1, <1.08, < 10th centile) have been shown to be associated with adverse perinatal outcomes .[36]

SGA is defined as small for gestational age with EFW < 10th percentile for required gestational age. USG estimation of fetal weight and abdominal circumference has been used for diagnosis of FGR. Doppler of umbilical artery, ductus venosus and middle cerebral artery (MCA) has proven role management of SGA or FGR fetuses, as it best correlates with fetal outcome.

Most of the studies have compared perinatal outcomes in SGA fetuses with normal and abnormal CPR on doppler, therefore this study was done in women with AGA fetuses to understand the predictability of ultrasound dopplers in diagnosing fetal distress and the outcome accordingly.

The baseline characteristics were comparable to most of the previously conducted studies. The demographic profile of the patients including age in present study was compared to the previous studies. The reported age in various studies was ranging from 19-38 years (Table20). The mean age of patients included in our study is lesser (26.3+/-3.9 years) as compared to those in the previous studies which is explained by the fact of early childbearing age in our region.

Table 20: Age distribution in various studies

	MEAN AGE
Chainarong N, et al (2018)[1]	29 (26 - 33) *
Fiolna M, et al (2019)[7]	28.7 (24.8–33.1) *
Khalil A, et al (2017)[5]	31.0 (27- 35) *
Karlsen HO, et al (2016)[2]	30 (17–43) *
F. Figueras et al (2010)[26]	31.8 ± 4.9
Prior T, et AL (2014)[6]	32.3 (16–47) *
Present study	26.3+/-3.9

Data expressed as Mean±SD *Data expressed as Median (Interquartile range)

The mean Period of gestation (POG) at ultrasound which was also the POG at enrollment was around 38-41 weeks in most previous studies as shown in Table 21. In Chainarong N, et al (2018) patients were enrolled in latent labour while Khalil A et al (2017) included patients with USG within 2 weeks of delivery so mostly previous studies included term patients. We enrolled patients at a fixed POG (35-37+6 weeks) to exclude early onset FGR.

Table 21: POG at USG in various studies

	POG AT USG
Chainarong N, et al (2018)[1]	275 (270 - 281) days
Khalil A, et al (2017) [5]	40.4 (38.4-41.4) weeks *
Flood et al (2014)[36]	29 -36 weeks
Prior T, et al (2014) [6]	37-42 weeks
F. Figueras et al (2010) [26]	34-40 weeks
Present Study	36.05(35-37+6) weeks

Data expressed as mean (range)

* Data expressed as median (interquartile range 1–3)

Mainstay of the study was to divide the study population in groups according to the doppler findings. The definition of abnormal or low CPR was different in various studies considered to be <5th centile and <1 in Chainarong N, et al, <1.08, <0.6765 MoM in Khalil et al, presently in our study we have used </=10th centile as cut off which was also similar to Prior T et al and F Figueras et al. In some studies, like Karlson et al conditional centiles of <5th and <10th centile were also used.

Incidence of abnormal doppler was compared in various studies and our study had higher incidence of low CPR (32%) as depicted in table (22) due to higher cut off as compared to previous studies and our institute being a tertiary care centre.

Table 22: Incidence of low CPR in various studies

	Incidence of low CPR
Chainarong N, et al (2018) [1]	52(13.5) *
Najam et al (2016) [4]	3(12%)
Prior t, et al (2014) [6]	66 (11.0%) #
Present study	55(32%) #

Data expressed as N (%)

*<5th centile

#<10th centile

We have compared fetal distress in patients with normal and abnormal groups by using CTG tracings as a tool. Abnormal and non-reassuring CTG tracings were both considered as CTG denoting fetal distress.

It was not comparable to previous studies due to less sample size, but p value was significant in all studies described below which was also observed in our study as shown in table (23). Our study had lower incidence of abnormal CTG tracings in both groups as we included only low risk patients while in other studies high risk patients with preeclampsia, diabetes (Chainarong N et al) or previously diagnosed SGA were also included (Prior T et al).

Table 23: Abnormal CTG tracings in various studies

	Abnormal CPR	**Normal CPR**	**p value**
Chainarong N, et al (2018) [1]	28(53.8%) *	93(28%) *	<0.01
Prior T, et al(2014) [6]	86%	31%	< .001
Present study	11(20%)	9(7.69%)	0.027

Data expressed as N (%)

*Used CPR cut off as 5th centile

The mean Period of gestation (POG) at delivery was around 38-40 weeks which is mostly term deliveries in previous studies which was comparable to index study (38 weeks) as shown in Table 24.

Table 24: Gestational age at delivery in various studies

	Gestational age at delivery
Karlsen HO, et al (2016) [2]	39+2 (25.3 - 42.3)
F. Figueras et al (2010) [26]	38.1weeks
Prior T, et al (2014) [6]	40.5 weeks (37.0–42.0)
Present study	38 weeks (35-42)

Data expressed as median (interquartile range 1–3)

Various perinatal outcomes like mode of delivery, operative delivery due to fetal distress ,low APGAR scores , birth weight , meconium staining , NICU admission ,umbilical cord Ph , fetal outcome, neonatal complications were observed in various studies .

Mode of delivery included normal vaginal delivery, operative /instrumental vagina delivery and cesarean section was comparable to Najam et al in abnormal CPR group table (25). We had increased rates of cesarean /operative vaginal delivery in normal CPR group also in our study as compared to Najam et al which is attributed to other indications of cesarean section like previous cesarean not willing for TOLAC and failed inductions.

Table 25: Mode of delivery in various studies

	Abnormal CPR	**Normal CPR**	**p value**
Najam et al (2016) [4]	27 (47%) 30 (52.6%)	58(75%), 19 (24.5%)	
Present study	27 (49%), 28(50%)	67(57.2%), 50(42.7%)	0.44

Data expressed as Vaginal delivery N (%), operative delivery N (%)

Operative delivery due to fetal distress was compared in various studies table (26). It was significant in most studies (Khalil A, et al, Karlsen HO, et al, F. Figueras et al and Prior T, et al).

In index study operative delivery was higher in abnormal CPR group as compared to normal CPR group but was not significant(p-0.38). The difference can be explained by the cohort included in the various studies which didn't exclude high risk pregnancies likewise only SGA or patients with increased risk of SGA were recruited in Karlson HO et al. Another reason could be due to various definitions of fetal distress at which caesarean was done which was not mentioned the previous studies

Table 26: Operative delivery due to fetal distress in various studies

	Abnormal CPR	**Normal CPR**	**p value**
Chainarong N, et al (2018) [1] ^	10 (19.2%)	43 (12.9%)	0.31
Najam et al (2016) [4]	30 (52.63%)	3 (3.89%)	--
Fiolna m, et al (2019) [7]	48(23.6%)	--	0.263
Khalil a, et al (2015) [5] *****	13.1%	9.4%	< .01
Karlsen ho, et al (2016) [2]	31(52%)	17(12%)	0.032
F. Figueras et al (2010) [26]	79.1%	10.7%	< .001
Prior T, et al (2014) [6]	36.4%	10.1%	< .001
Present study	10(40%)	14(29.78%)	0.38

*CPR cut off used as <0.6765 MoM

^CPR cut off used as <5th centile

Data expressed as N (%)

Meconium staining during delivery was observed in our study was comparable to Chainarong N et Al in abnormal CPR group as depicted in the table 27 was not significant in both studies (p>0.05), as it was a subjective finding different observations were found in previous studies.

Table 27: Meconium stained liquor in various studies

	Abnormal CPR	**Normal CPR**	**p value**
Chainarong N, et al (2018) [1]	6 (11.5%)	57 (17%)	0.41
Prior T, et al(2014) [6]	22%	9%	0.02
Najam et al (2016) [4]*****	25 (43.85%)	1 (1.29%)	--
Present study	4(7.27%)	10 (8.54%)	0.7

Data expressed as N (%)

APGAR score was calculated at 1' and 5' minutes but in previous studies APGAR scores compared at 5 minutes only with low APGAR cut off as </=7. It was found to be equal in both groups p value- 0.9 which was similar to Chainarong N et al table (28), it was not significant in most studies due to prompt and effective neonatal resuscitation at tertiary care hospitals and interobserver variation of pediatrician. However, APGAR scores were lower in Najam et al as high risk pregnancies were also included in the study.

Table 28 : APGAR scores <7 at 5 min in various studies

	Abnormal CPR	**Normal CPR**	**p value**
Chainarong N, et al (2018) [1]	0 (0)	1 (0.3)	1
Najam et al (2016) [4]*****	19 (33.33%)	1 (1.29%)	--
F. Figueras et al (2010) [26]	0.7%	1.3%	>0.05
Present study	3(5%)	6(5.5%)	0.9

* low APGAR scores

Data expressed as N (%)

Mean birth weights were compared in all studies and found to statistically significant in both groups , in majority of previous studies table (29) while some studies compared birth weight centiles(<10^{th} centile) .Mean birth weight was lower in low CPR groups, as compared to normal CPR group which is comparable to our index study .

Table 29: Mean Birth weight distribution in various studies

	Abnormal CPR	**Normal CPR**	**p value**
Chainarong N, et al (2018) [1]	3035+/- 435	3194 +/-425	0.01
F. Figueras et al (2010) [26]	2280	2466	< .001
Flood et al (2014) [36]	1763	2611	<0.001
Present study	2587+/-454	2873+/-431	<0.0001

Data expresses as mean +/- SD

NICU admission were compared in various studies but cause, duration of stay was not mentioned. NICU admission were more in Khalil A, et al and Flood et al with statistical significance as shown in table (30)

However, in our study NICU admissions were comparable to Chainarong et al which was not significant. The cause of lesser NICU admission is due to lower sample size, NICU facilities at various centres , exclusion of high risk pregnancies and various causes of neonatal admissions

Table 30: NICU admission in various studies

	Abnormal CPR	Normal CPR	p value
Chainarong N, et al (2018)[1]	2 (3.8)	4 (1.2)	0.19
Khalil a, et al (2017)[5]	14.3%	9.7%	0.004
Karlsen ho, et al (2016)[2]	33(55%)	12(8%)	0.048
Najam et al (2016)[4]*	36 (63.16%)	12 (15.58%)	--
Flood et al (2014)[36]	64%	22%	<0.001
Present study	2(5.3%)	5(3.5%)	0.68

Data expressed as N (%)

Finally, CPR as a tool for predicting perinatal outcomes was compared in previous studies using PPV and NPV

In our study CPR <10th centile has a positive predictive value of 18.18% for non-reassuring and 20% for abnormal CTG patterns while negative predictive value of reassuring CTG was 81.19% which was comparable to Chainarong N et al as described in table (31)

Najam et al and Karlsen ho, et al have higher positive predictive value as they included high risk pregnancies and patients with already diagnosed SGA or at risk of SGA respectively.

Table 31: PPV and NPV of CPR in various studies

	PPV	NPV
Chainarong N, et al (2018)[1]*	23%/18%	90%/87%
Prior T, et al(2014)[6]	36%	99%
Karlsen HO, et al (2016)[2#]	73.3%	--
Najam et al (2016)[4]^	80.7%	92.3%
Present study	20%/18.18%	81.19%

*for Non-reassuring /abnormal CTG patterns

For any adverse perinatal outcome

^ for detecting IUGR

Previous studies also compared the use of umbilical artery (UA) or middle cerebral artery (MCA) or CPR alone to predict perinatal outcomes. If CPR can be used in addition to UA or EFWt but there was no extra benefit as compared to UA alone.

Majority of studies observed that CPR has good negative predictive value which can be used in future.

STRENGTH AND LIMITATIONS

Strength of study- It was a prospective cohort study, and one of the few studies done in western India. Total 172 patients were recruited in the study. No previous study has analyzed the outcomes in AGA fetuses not in labour. We excluded the chronic illness, major fetal malformations which are responsible for FGR, which were included in most of the previous studies. The patients were followed till delivery and postnatal period in hospital stay. Only 5 patients were lost to follow up from the study population.

The limitation of the study was that the we used centiles for CPR and not actual value, using 10^{th} centile attributed to higher incidence of abnormal CPR. APGAR was based as per pediatrician perception and was a subjective finding with interobserver variations. Meconium staining was also subjected to inter observer variations.

Longer follow up may be required regarding fetal outcomes like neurodevelopmental sequalae feeding problems and immune dysfunction. The higher rates CPR was due to higher cut off ($<10^{th}$ centile) whereas most of the studies described cut off as actual value (1/1.06), or 5^{th} centile or in terms MoM while some calculated composite risk score derived by dopplers in their studies. The lower rate of adverse perinatal outcome in our study can be attributed to the fact that the study was done in a tertiary care centre with all the facilities for prevention perinatal asphyxia. These facilities may not be available at peripheral hospital; hence the findings of the study cannot be implemented for the entire population. In our study we have higher rates of cesarean section in normal CPR group which is attributes to other causes. Other options of using middle cerebral artery (MCA) alone, anterior cerebral artery (ACA) alone or uterine artery doppler can be compared with adverse perinatal outcomes in further studies.

CONCLUSION

This was a prospective cohort study considering application of antepartum cerebroplacental ratio in predicting adverse perinatal outcomes conducted in the department of Obstetrics and Gynecology at AIIMS, Jodhpur from March 2021 to November 2022.

• Total 172 patients were enrolled and ultrasound was done and based on doppler findings was divided into two groups- 55 patients had abnormal doppler (CPR< 10^{th} centile) and 117 patients had normal doppler (CPR>10^{th} centile)

• Inclusion criteria included women with singleton viable pregnancies between 35 to 37+6 weeks after ruling out prenatally diagnosed fetal anomalies.

• Exclusion criteria included inability to obtain informed consent, chronic diseases(e.g. Diabetes Mellitus , chronic hypertension , Autoimmune disorders, Hematologic disorders, HIV, Renal insufficiency, chronic lung disease, seizure disorder on medication, thyroid disease on medication, psychiatric disorder), malpresentations, multiple pregnancy, planned cesarean delivery , pregnancy with diagnosed FGR (fetal growth restriction) before 35 weeks , fetal demise and major fetal anomalies including (Anencephaly, Spina bifida, Bilateral renal agenesis, Cystic hygroma with hydrops, Diaphragmatic hernia, Congenital heart defects).

• Mean age of the patients was 26.3±3.9 years. Mean age of patients was 25.64±3.5 in abnormal CPR group I and mean age of patients in normal CPR group II was 26.62±4.05. The patients in two groups were comparable in terms of age.

• Majority of patients were graduates or studied up to senior secondary in both the groups – (34.5 %) in abnormal CPR group I and (31.6 %) in normal CPR group II.

• Majority of the patients in both the groups were house wives – (74%) in abnormal CPR group I and (78%) in normal CPR group II

Most patients resided in urban background (41%) in abnormal CPR group I and (38%) in normal CPR group II was comparable in both groups

• Mean POG at ultrasound in the study population for abnormal CPR group I was 35.98±0.93 weeks and for normal CPR group II was 36.08±0.93 weeks. Both the groups were comparable in terms of POG at delivery.

At delivery the gestational age of patients was comparable in both groups (38.18 +/-1.27 weeks in normal CPR group vs 38.49+/-1.38 weeks in abnormal CPR group).

The incidence of abnormal CPR was (31.9%) in our study population.

Reassuring CTG tracings was observed in (61.81%) of patients with normal CPR group I and (81.19 %) with abnormal CPR. A significantly higher number of patients had abnormal CTG with abnormal CPR as compared to normal CPR (p value = 0.027). Only 2 patients had IUD in the study population with CPR<1 and CPR -81 centile respectively. Cesarean or operative vaginal delivery was done in (45.45%) and (5.45%) respectively in abnormal CPR group while 40.17% and 2.56 % in normal CPR group .

• APGAR scores at 1 minute of life was 8-9 in 70.9 % and </= 7 in 29.09 % with normal CPR , 84.34 % had 8-9 APGAR and </=7 in 19.35% in normal CPR group . However, the difference was not significant

• Similarly APGAR score at 5 minute of life was </=7 in 5.54 % in abnormal CPR group and 5.12% in normal CPR group which was almost similar in both groups .

Majority of the patients (54.54 % in abnormal CPR vs 78.63 % in normal CPR group) had normal birth weight of >2.5 Kg . The rates were higher in normal CPR group but not significant (p-0.08). We observed significantly higher Low birth weight rates in abnormal CPR group with 45.45 % value while in normal CPR group it was 21.36 %.

• Meconium staining of liquor was present in 7.27% of patient in abnormal CPR group as compared to 8.54% in normal CPR group diagnosed intrapartum in vaginal delivery or cesarean section which was comparable in both groups

More neonates were admitted in NICU in normal CPR group (4.27%) as compared to 3.63 % in abnormal CPR group which not significant (p- 0.87)

• The most common indication for LSCS in the study population was previous 1 LSCS not willing for Trial of Labour after Caesarean section (TOLAC) . It accounted for 36% both groups • It was followed by fetal distress which was reflected by pathological CTG / severe oligohydramnios with FGR / anhydramnios or meconium staining with suspicious CTG which accounted for 40 % patients in abnormal CPR group and 29.78% in normal CPR group .

The predicted odds of non reassuring / abnormal CTG tracings for abnormal CPR (10^{th} centile)are 2.61 times higher than odds in normal CPR ($>10^{th}$ centile). i.e patients with abnormal CPR are 2.61 times more likely to have non reassuring /abnormal CTG tracings during labour than patients with normal CPR .

According to our study CPR ratio calculated after 35 weeks has a positive predictive value of 18.18% for non reassuring and 20% for abnormal CTG tracings ; i.e. in patients with CPR $<10^{th}$ centile 20 % will have abnormal CTG tracings during labour.

In patients with CPR$>10^{th}$ centile 81.19 % will have reassuring CTG during labour thus a NPV of 81.19%

There is a minimal increase in probability of detecting non reassuring /abnormal CTG with use of CPR (likelihood ratio =1.85)

It is concluded from our study that use of antepartum cerebroplacental ratio in low risk pregnancy has resulted in increased in rate of abnormal CTG tracings in patients during labour with low CPR along with association of low birth weight . Although other perinatal outcomes were comparable in both the groups. However, CPR measurement has a good negative predictive value to stratify women who may benefit from CTG monitoring.

Hence, concurrent use of CPR with cardiotocography may be used for labor triage , intrapartum monitoring of patients and can plan timing and mode of delivery but merits further trials .

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संस्थागत नैतिकता समिति
Institutional Ethics Committee

No. AIIMS/IEC/2021/3485 Date: 12/03/2021

ETHICAL CLEARANCE CERTIFICATE

Certificate Reference Number: **AIIMS/IEC/2021/3320**

Project title: **"Antepartum cerebroplacental ratio (CPR) in low risk pregnancy and its relationship with adverse perinatal outcome- A prospective cohort study"**

Nature of Project:	**Research Project Submitted for Expedited Review**
Submitted as:	**M.D. Dissertation**
Student Name:	**Dr. Neha Rathore**
Guide:	**Dr. Manu Goyal**
Co-Guide:	**Dr. Pratibha Singh, Dr. Shashank Shekhar & Dr. Taruna Yadav**

Institutional Ethics Committee after thorough consideration accorded its approval on above project.

The investigator may therefore commence the research from the date of this certificate, using the reference number indicated above.

Please note that the AIIMS IEC must be informed immediately of:

- Any material change in the conditions or undertakings mentioned in the document.
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research.

The Principal Investigator must report to the AIIMS IEC in the prescribed format, where applicable, bi-annually, and at the end of the project, in respect of ethical compliance.

AIIMS IEC retains the right to withdraw or amend this if:

- Any unethical principle or practices are revealed or suspected
- Relevant information has been withheld or misrepresented

AIIMS IEC shall have an access to any information or data at any time during the course or after completion of the project.

Please Note that this approval will be rectified whenever it is possible to hold a meeting in person of the Institutional Ethics Committee. It is possible that the PI may be asked to give more clarifications or the Institutional Ethics Committee may withhold the project. The Institutional Ethics Committee is adopting this procedure due to COVID-19 (Corona Virus) situation.

If the Institutional Ethics Committee does not get back to you, this means your project has been cleared by the IEC.

On behalf of Ethics Committee, I wish you success in your research.

Dr. Praveen Sharma
Member Secretary

Member secretary
Institutional Ethics Committee
AIIMS,Jodhpur

Basni Phase-2, Jodhpur, Rajasthan-342005; **Website:** www.aiimsjodhpur.edu.in; **Phone:** 0291-2740741 Extn. 3109
E-mail : ethicscommittee@aiimsjodhpur.edu.in; ethicscommitteeaiimsjdh@gmail.com

Patient Information sheet (PIS)

You are invited to take part in this study entitled "**Antepartum cerebroplacental ratio in low risk pregnancy and its relationship with adverse perinatal outcome – a prospective cohort study"**

It is informed that it is entirely voluntary and you may refuse to take part or discontinue at any time without losing your right to adequate gynecological care.

This research is aimed at comparing the relationship between cerebroplacental ratio and adverse perinatal outcomes. After your consent sonography will be done at 35 to 37 + 6 week gestation and routine care will be followed
Even if you refuse to participate in this study the investigations and the appropriate treatment will be carried out as a regular protocol.

The study requires routine investigations to be performed and hence the cost of the investigations has to be borne by you as these are not any extra tests.

The expected duration of your participation in this study is 6 weeks.
There is no specific complication due to the study.

All the records will be kept confidential.

You have the right to ask for any further information that you require.

In case of any doubt regarding the study you are welcome to contact the undersigned personally or by telephone (7792999076)

रोगी सूचना पत्र

आपको इस अध्ययन में भाग लेने के लिए आमंत्रित किया गया है "**लो रिस्क प्रेग्नेंसी में एंटीपार्टम सेरिब्रल प्लेसेंटल अनुपात और प्रतिकूल प्रसवकालीन परिणाम के बीच संबंध- भावी कोहोर्ट अध्ययन** "

यह सूचित किया जाता है कि यह पूरी तरह से स्वैच्छिक है और आप पर्याप्त स्त्री रोग संबंधी देखभाल के अपने अधिकार को खोए बिना किसी भी समय हिस्सा ले सकते हैं या बाहर निकल सकते हैं।

- यह शोध सेरिब्रल प्लेसेंटल अनुपात और प्रतिकूल प्रसवकालीन परिणामों के बीच संबंध की तुलना करने के उद्देश्य से है। आपकी सहमति के बाद 35 से 37 + 6 सप्ताह की सोनोग्राफी की जाएगी और नियमित देखभाल की जाएगी यहां तक कि अगर आप इस अध्ययन में भाग लेने से इनकार करते हैं तो जांच और उचित उपचार नियमित प्रोटोकॉल के रूप में किया जाएगा।
- इस अध्ययन में आपकी भागीदारी की अपेक्षित अवधि 6 सप्ताह है।
- अध्ययन के कारण कोई विशिष्ट नुकसान नहीं है।

सभी रिकॉर्ड गोपनीय रखें जायेंगे।आपके पास किसी भी प्रकार की अधिक जानकारी लेने का अधिकार है।अध्ययन के बारे में किसी भी संदेह की स्थिति में आपका व्यक्तिगत रूप से या टेलीफ़ोनिक रूप से संपर्क करने के लिए स्वागत है I

<u>जांचकर्ता का बयान</u>

मैंने अध्ययन के उद्देश्य, प्रक्रियाओं, लाभ और हानि को रोगी / रोगी के रिश्तेदार को विस्तार से समझाया है।
अध्ययन के बारे में सभी जानकारी का खुलासा किया गया है।
अध्ययन के संबंध में प्रश्न पूछने के लिए पर्याप्त समय और अवसर रोगी / रोगी के रिश्तेदार को दिया गया था।

जांचकर्ता हस्ताक्षर: - साक्षी हस्ताक्षर:

डॉ। नेहा राठौड़

(फ़ोन नंबर: 7792999076)

All India Institute of Medical Sciences
Jodhpur, Rajasthan
Informed Consent Form

Title of Thesis/Dissertation: "**Antepartum cerebroplacental ratio in low risk pregnancy and its relationship with adverse perinatal outcome."**

Name of PG Student : Dr. Neha Rathore Tel. No. : 7792999076

Patient/Volunteer Identification No. : _____

I, _____ W/o or D/o _____

R/o _____

give my full, free, voluntary consent to be a part of the study "**Antepartum cerebroplacental ratio in low risk pregnancy and its relationship with adverse perinatal outcome – a prospective cohort study"** the procedure and nature of which has been explained to me in my own language to my full satisfaction. I confirm that I have had the opportunity to ask questions. I fully understand that any of the above mentioned observation can be given to me, still I want to be a part of study.

I understand that my participation is voluntary and am aware of my right to opt out of the study at any time without giving any reason.

I understand that the information collected about me and any of my medical records may be looked at by responsible individual from AIIMS, Jodhpur or from regulatory authorities. I give permission for these individuals to have access to my records.

Date: _____ _____

Place: _____ Signature/Left thumb impression

This to certify that the above consent has been obtained in my presence.

Date: _____ _____

Place: _____ Signature of PG Student

Witness 1 2. Witness

_____ _____

Signature Signature

Name: _____ Name:

_____

Address: _____ Address: _____

ऑल इंडिया इंस्टिट्यूट ऑफ मैडिकल साईंसिस

जोधपुर, राजस्थान

सूचित सहमति प्रपत्र

थीसिस / निबंध का शीर्षक: **" लो रिस्क प्रेग्नेंसी में एंटीपार्टम सेरिब्रल प्लेसेंटल अनुपात और प्रतिकूल प्रसवकालीन परिणाम के बीच संबंध- भावी कोहोर्ट अध्ययन "**

पीजी छात्र का नाम: डॉ। नेहा राठौड़ दूरभाष।संख्या: 7792999076

रोगी / स्वयं सेवक पहचान संख्या: _____

मैं_____पत्नी/पुत्री_____

निवासी_____ अध्ययन"

लो रिस्क प्रेग्नेंसी में एंटीपार्टम सेरिब्रल प्लेसेंटल अनुपात और प्रतिकूल प्रसवकालीन परिणाम के बीच संबंध- भावी कोहोर्ट अध्ययन " में भाग लेने के लिए मेरी पूर्ण, स्वतंत्र, स्वैच्छिक सहमति देती हूं, जिसकी प्रक्रिया और प्रकृति मुझे मेरी भाषा में समझाई गई है। मैं पुष्टि करती हूं कि मुझे प्रश्न पूछने का अवसर मिला है। मैं समझती हूं कि मेरी भागीदारी स्वैच्छिक है और मुझे किसी भी समय अध्ययन से बाहर निकलने का अधिकार है| । मैं समझती हूं कि मेरे और मेरे मेडिकल रिकॉर्ड के बारे में एकत्रित की गई जानकारी को ऑल इंडिया इंस्टिट्यूट ऑफ मैडिकल साईंसिस के जिम्मेदार व्यक्ति द्वारा देखा जा सकता है |मैं इन लोगों को मेरे रिकॉर्ड देखने की अनुमति देती हूं|

तारीख : _____

जगह: _____ हस्ताक्षर / बाएं अंगूठे का छाप

यह प्रमाणित करने के लिए कि मेरी उपस्थिति में उपरोक्त सहमति प्राप्त की गई है

तारीख : _____ _____

जगह: _____ पीजी छात्र के हस्ताक्षर

1. गवाह 2.गवाह

_____ _____

हस्ताक्षर हस्ताक्षर

नाम _____ नाम: _____

पता _____ पता : _____

APPENDIX 1

CASE RECORD SHEET: -
(Principal Investigator- Dr. Neha Rathore)

- Name : Registration Id:
- Age: Qualification:
- Occupation: Residence:
- Chief complaints mobile no.
- HOPP
- Menstrual History:

  Menstrual cycle-

  LMP-

  POG-

  EDD-

- Obstetric History:

- Past History:

- Family History:

- Personal History:

On Examination:

- General condition
- Pulse rate /min Blood pressure(mmHg)
- Respiratory rate/min Temperature
- Pallor / Icterus/ Cyanosis/ Clubbing/ Lymphadenopathy/ Edema
- Weight(Kg): Height(cm): Body Mass Index(Kg/m^2)
- Central Nervous System:
- Respiratory System:
- Cardio-Vascular System:
- Per-Abdomen :

Final Diagnosis:

- **INVESTIGATIONS:**

	DATE
Blood Group	
CBC-Hb GTT-	

- USG- doppler

3rd trimester scan(35-38 week):

Middle cerebral artery MCA PI-
Umbilical artery UA PI-
Cerebroplacental ratio CPR-

Presentation-
Placenta-

Liquor-
EFWt-

- Labour- Term/Preterm

  Gestational age at delivery -

  Onset- Spontaneous/ Induced
  Indication of induction-
  CTG finding :
  Non reassuring/abnormal fetal status during labour – YES/NO

- Type of delivery- Vaginal delivery/Cesarean section/operative vaginal delivery

  Indication-
  Amniotic fluid – clear/ meconium stained

Baby details- Date & Time of Birth

Gender-

APGAR-

Weight (gm) NICU admission- YES/NO

At the time of discharge:

Maternal Outcome	Neonatal outcome

Registration ID	Age	Occupation	Socioeconomic status	Residence	Education	Parity/Gravida	POG at USC	Liquor amo	EFWt	MCA PI	UA PI	CPR	CPR centile	CPR group	Gestational age at delivery	CTG	Labour	Type of delivery	Indication of Iscs /operative vaginal delivery	Meconium staining	Birth weight	APGAR at 1'	APGAR at 5'	NICU admission
2020/12/006121	25	1	2	2	4	1	1	1	2500	1.82	1.2	1.5	11	1	2	1	Term	2	3	1	1	1	1	1
2020/03/002006	25	1	2	1	1	1	1	1	2593	1.41	0.79	1.78	31	1	2	2	Term	1		1	1	2	1	1
2020/12/001266	21	1	3	3	4	1	2	1	2380	1.17	1.45	0.81	1	2	2	2	Term	1		1	2	2	1	1
2020/12/008504	23	1	2	2	1	2	1	1	2905	1.26	0.98	0.98	1	2	2	2	Term	2	2	1	2	2	1	1
2020/12/009090	29	1	2	1	3	1	3	1	3823	1.67	0.77	2.16	71	1	3	1	Term	1		2	1	1	1	1
2021/01/014625	24	1	2	3	1	2	2	1	3074	1.3	1.1	1.18	2	2	3	1	Term	1		1	1	2	1	1
2021/02/010686	26	1	1	1	1	2	2	1	2874	1.43	0.82	1.74	32	1	3	2	Term	1		1	1	1	1	1
2020/09/001655	23	1	2	1	3	2	2	1	2437	1.67	1.2	1.39	7	2	3	2	Term	1		1	1	1	1	1
2021/04/009074	22	1	2	1	3	1	1	1	2433	1.49	0.8	1.87	40	1	3	1	Term	1		1	1	1	1	1
2020/10/007832	25	1	2	3	5	3	2	1	3031	1.13	0.81	1.39	7	2	2	2	Term	2	2	1	1	1	1	1
2020/12/005102	35	1	2	2	4	>3	1	1	2757	1.76	0.81	2.1	68	1	3	1	Term	2	2	1	1	1	1	1
2021/09/000488	25	1	1	1	1	1	3	1	3190	1.6	0.77	2.07	66	1	2	2	Term	2	3	2	1	2	1	1
2021/04/012180	21	1	2	1	4	1	1	1	2543	2.37	1.05	2.25	73	1	3	3	Term	2	1	1	2	1	1	1
2020/12/006257	25	1	2	1	2	2	3	1	3235	1.31	0.73	1.79	42	1	3	1	Term	1		1	1	1	1	1
2021/03/013776	24	1	2	1	1	3	3	1	3186	1.01	0.86	1.17	2	2	2	1	Term	1		1	1	1	1	1
2021/04/002325	31	1	2	1	5	2	2	1	2484	1.91	0.99	1.9	47	1	2	2	Term	2	1	1	1	2	1	1
2021/04/006665	22	1	2	1	3	1	2	1	2250	1.36	1.21	1.12	1	2	2	3	Term	2	1	1	2	1	1	1
2020/12/005537	22	1	2	3	5	2	3	1	2657	1.38	1.1	1.2	5	2	2	2	Term	2	3	2	1	1	1	1
2021/05/006376	19	2	3	3	3	1	3	1	2846	1.29	0.78	1.6	30	1	2	1	Term	1		1	1	2	1	1
2021/04/001441	25	1	3	3	1	2	3	1	2737	1.52	0.82	1.8	1.8	2	3	3	Term	2	1	1	1	1	1	1
2020/08/005518	24	1	3	1	1	1	1	1	2431	1.55	0.85	1.8	1.8	2	1	1	Preterm	1		1	2	1	1	1
2021/04/002166	27	1	2	1	3	3	3	1	2339	1.64	0.61	2.6	95	1	2	1	Term	2	2	1	2	1	1	1
2020/09/001542	28	3	1	1	1	2	1	1	2275	1.64	0.92	1.81	33	1	2	3	Term	2	1	1	1	1	1	1
2021/03/011324	31	3	1	1	1	2	3	1	3469	1.36	0.76	1.7	49	1	3	2	Term	3	1	2	1	2	2	2
2021/02/009781	27	1	2	2	3	>3	1	1	2505	1.39	1.07	1.29	3	2	3	1	Term	1		1	1	2	1	1
2021/04/009691	26	1	3	3	4	2	3	1	2798	1.38	1.25	1.05	1	2	2	2	Term	2	2	1	1	2	2	2
2021/06/003189	28	1	3	3	3	>3	1	1	2611	1.17	0.97	1.2	1	2	2	2	Term	3	1	1	2	1	1	1
2015/10/008105	29	1	2	3	3	>3	1	1	2568	1.64	1.04	1.57	14	1	3	1	Term	1		1	1	1	1	1
2021/06/005427	28	4	2	2	4	>3	3	1	2316	0.88	1.01	0.88	1	2	2	1	Term	2	2	1	2	1	1	1
2021/04/001312	22	1	3	3	3	2	1	1	2883	1.4	1	1.4	6	2	3	1	Term	2	2	1	1	1	1	1
2021/07/003201	26	1	2	1	3	2	1	1	2408	1.2	0.9	1.3	7	2	2	1	Term	1		1	2	1	1	1
2021/05/003710	21	1	2	3	4	2	1	2	2584	1.62	0.8	2.1	62	1	2	1	Term	2	3	1	1	1	1	1
2021/07/002489	22	5	1	1	1	1	2	1	2757	1.09	0.93	1.17	3	2	2	3	Term	2	3	1	1	2	1	1
2021/06/012932	31	1	2	3	3	>3	2	2	2732	1.29	0.74	1.75	27	1	3	1	Term	2	2	1	1	2	1	2
2020/10/005171	21	1	2	3	3	1	3	1	3313	1.27	0.73	1.7	37	1	2	3	Term	2	1	1	1	1	1	1
2021/04/002745	27	1	2	3	3	1	1	1	1904	1.08	0.81	1.33	3	2	2	3	Term	2	1	1	2	1	1	1
2021/06/014485	26	1	2	3	3	1	1	1	2197	3.1	1.07	2.8	97	1	2	3	Term	2	1	1	2	1	1	1
2021/03/006852	25	1	2	3	3	1	1	1	2588	1.5	0.82	1.8	35	1	2	1	Term	2	3	2	1	2	1	1
2021/04/003558	28	1	2	3	5	1	2	1	2219	2.04	0.9	2.26	77	1	2	1	Term	2	3	1	1	2	1	2
2020/12/008126	20	1	2	3	4	1	2	1	2237	1.4	1.17	1.19	2	2	2	1	Term	1		1	2	2	1	1
2021/01/015792	24	1	1	3	1	1	3	2	2959	1.85	0.71	2.6	92	1	3	3	Term	2	1	1	1	2	1	1
2018/06/008678	22	1	2	3	4	3	3	1	2418	1.62	1.05	1.54	19	1	1	1	Term	1		1	1	2	1	1
2021/06/005258	32	1	2	3	4	3	2	1	1993	2.1	0.7	3	98	1	2	1	Term	1		1	2	1	1	1
2018/05/013408	35	1	2	3	1	3	1	1	2257	1.5	0.53	2.8	96	1	3	1	Term	1		1	1	1	1	2
2021/12/018370	24	1	2	3	4	1	1	1	2484	1.74	0.92	1.8	52	1	2	2	Term	2	1	2	1	2	1	1
2021/09/000952	25	1	1	2	5	1	1	1	2613	1.2	0.8	1.5	11	1	3	1	Term	1		1	1	1	1	1
2021/09/017929	21	1	2	3	3	3	1	1	2654	1.96	0.63	2.11	98	1	2	1	Term	2	1	2	1	1	1	1
2021/02/009734	30	6	2	3	1	1	2	1	2081	1.53	0.94	1.62	20	1	2	3	Term	2	1	1	2	1	1	1
2020/08/008712	27	7	1	1	1	2	1	1	2570	1.47	1.08	1.36	4	2	2	3	Term	2	1	1	1	2	1	1
2021/05/004076	27	7	1	1	1	2	1	1	2681	2	0.94	2.12	64	1	3	1	Term	2	3	1	1	1	1	1
2021/07/002130	33	1	2	1	5	1	3	1	3166	1.4	0.74	1.89	50	1	2	1	Term	2	3	1	1	1	1	1
2021/09/009414	28	1	2	2	4	>3	2	1	3016	1.4	0.51	2.74	95	1	3	1	Term	2	2	1	1	1	1	1
2017/03/013768	25	1	2	2	3	3	1	1	2897	1.42	0.85	1.6	31	1	3	1	Term	1		1	1	1	1	1
2021/07/003845	26	1	2	3	4	3	3	3	3000	1.47	0.8	1.8	44	1	3	1	Term	2	2	1	1	1	1	1
2021/06/013351	23	5	2	1	1	1	2	1	2421	3.3	0.93	2.03	59	1	2	1	Term	2	1	2	2	1	1	1
2021/05/008642	26	7	1	1	2	2	2	1	2620	1.97	0.97	2.03	59	1	3	1	Term	1		1	1	1	1	1
2021/12/011513	34	1	1	1	1	3	2	2	2863	1.7	0.75	2.26	76	1	2	1	Term	2	2	1	1	1	1	1
2021/11/012831	25	1	2	2	4	1	1	1	2382	1.4	1.2	1.16	1	2	2	3	Term	1		1	1	2	1	1
2021/07/007110	20	1	2	2	1	1	2	1	2504	1.8	1.1	1.6	23	1	2	1	Term	1		1	2	2	1	1
2021/08/006582	31	1	2	1	3	1	1	1	2618	1.68	0.8	2	63	1	2	1	Term	1		1	1	1	1	1
2021/08/015473	23	1	2	3	4	>3	2	1	3039	1.29	0.63	2.04	59	1	1	1	Term	2	3	1	2	1	1	1
2022/02/001436	28	1	2	1	3	>3	3	1	2315	1.63	0.9	1.81	30	1	3	1	Term	1		1	1	1	1	1
2014/11/000131	25	1	2	1	1	3	1	2	2415	1.09	0.94	1.159	1	2	3	1	Term	1		1	1	1	1	1
2021/07/010049	30	1	3	2	3	3	1	1	2300	2.4	1.02	2.34	81	1	2	1	Term	1		1	1	1	1	1
2021/02/010468	26	1	2	1	1	1	2	1	2413	1.41	0.6	2.34	81	1	2	1	Term	1		1	1	3	2	1
2018/02/001576	31	1	3	3	3	1	1	1	2710	1.07	1.15	0.93	1	2	3	1	Term	1		2	1	1	1	1
2021/01/022800	24	1	2	1	1	1	2	1	2611	1.67	0.97	1.72	30	1	2	1	Term	1		1	1	1	1	1
2021/06/008672	22	1	2	2	3	1	2	1	2338	1.5	0.69	2.17	67	1	2	1	Term	1		1	1	2	1	1
2021/09/015928	25	1	3	3	4	1	1	1	2623	1.32	0.95	1.38	5	2	3	1	Term	1		1	1	1	1	1
2018/08/009354	30	1	2	1	1	3	1	3	2630	1.39	0.97	1.43	7	2	3	1	Term	1		1	1	1	1	1
2021/05/010166	22	1	2	2	3	1	3	1	3092	1.93	1.2	1.6	24	1	2	1	Term	1		1	1	1	1	1
2019/08/007481	29	1	1	1	1	1	1	1	2455	1.84	0.98	1.88	40	1	3	1	Term	1		1	1	1	1	1
2021/09/010364	22	1	2	2	3	1	1	1	2398	1.72	1.04	1.65	25	1	2	1	Term	1		1	1	1	1	1
2020/12/000013	36	1	2	2	3	3	3	1	3040	1.37	0.8	1.71	33	1	3	1	Term	2	2	1	1	1	1	1
2021/07/001433	32	1	2	1	3	1	3	1	2369	1.7	1	1.7	33	1	2	3	Term	3	1	1	2	1	1	1
2018/06/008678	35	1	2	2	3	3	3	1	2418	1.62	1.05	1.54	19	1	2	1	Term	1		1	1	2	1	1
2021/08/010375	23	2	2	1	1	2	2	1	285	1.7	1.05	1.619	21	1	3	1	Term	1		1	1	1	1	1
2016/12/007319	22	1	1	3	1	1	2	1	2783	1.38	0.77	1.7	34	1	2	1	Term	1		1	1	1	1	1
2022/02/001436	28	5	1	1	2	>3	1	1	2560	1.63	0.91	1.81	35	1	3	1	Term	1		1	1	1	1	1
2021/11/011460	24	1	2	1	1	1	2	1	2899	1.48	0.68	2.17	70	1	2	1	Term	1		1	1	1	1	1
2021/12/019349	26	1	2	3	4	1	1	1	2618	2.7	1.05	2.5	90	1	3	1	Term	2	3	1	1	1	1	1
2021/11/014239	27	1	2	3	4	2	1	1	2647	1.32	0.96	1.315	6	2	2	1	Term	2	2	1	1	1	1	1
2021/10/015471	25	5	1	1	1	>3	3	1	3326	1.84	1.06	1.74	34	1	2	1	Term	1		1	1	1	1	1
2017/07/012435	34	1	2	1	1	1	3	1	2446	1.1	0.8	1.37	9	2	2	3	Term	2	2	1	2	1	1	1
2021/11/012306	28	1	2	2	3	2	3	1	2459	1.56	1.31	1.19	1	2	3	1	Term	1		1	1	2	1	1
2021/02/004956	30	1	1	2	3	1	1	1	2780	2.24	1.24	1.8	35	1	3	1	Term	1		1	1	1	1	1
2021/12/007370	23	1	2	3	5	>3	2	1	2762	2	0.8	2.5	88	1	2	3	Term	2	1	1	2	1	1	1
2021/11/007990	29	1	2	3	3	>3	1	1	2614	1.52	1.02	1.4	11	1	3	1	Term	2	2	1	2	1	1	1

2021/11/013644	28	1	2	3	4	1	2	1	3001	1.55	0.56	2.76	95	1	2	2	Term	2	1	2	1	1	1	1
2021/11/003299	33	1	1	3	5	3	3	1	2485	1.35	0.89	1.52	16	1	3	1	Term	1		1	2	1	1	1
2022/02/014673	25	1	1	1	1	1	3	1	2696	2.39	1.03	2.32	81	1	2	1	Term	1		1	1	1	1	1
2021/11011060	25	7	2	2	3	1	1	1	2810	1.37	0.83	1.4	9	2	3	1	Term	1		1	1	1	1	1
2021/12/012786	22	1	1	3	5	2	2	1	2943	1.36	2.16	0.62	1	2	3	1	Term	3	3	1	1	1	1	1
2022/02/001254	28	1	1	1	5	3	1	1	2413	1.97	0.95	2.07	59	1	3	1	Term	2	2	1	1	1	1	1
2021/11/005950	21	1	2	2	3	1	1	1	2198	1.44	0.73	1.97	48	1	3	2	Term	2	3	1	1	1	1	1
2021/11/016535	23	5	1	1	1	1	2	1	2744	0.75	0.67	1.11	1	2	3	1	Term	1		1	1	2	1	1
2020/12/005310	27	1	2	3	3	1	2	1	2756	2.8	0.64	4.375	100	1	3	1	Term	1		1	1	1	1	1
2021/10/013385	24	5	1	1	1	1	1	1	2315	2.1	0.94	2.2	71	1	2	1	Term	1		1	1	1	2	1
2021/09/003143	33	1	2	1	4	2	3	1	2459	1.8	1	1.8	44	1	2	1	Term	1		1	1	1	1	1
2021/09/016344	22	7	2	2	3	1	2	1	2264	1.15	0.83	1.38	7	2	2	1	Term	1		1	1	1	1	1
2021/09/018806	26	7	2	2	3	2	1	1	2213	2.91	1	2.9	97	1	3	1	Term	2	3	1	1	1	1	1
2021/11/014663	26	5	2	1	2	1	1	1	2206	0.8	0.9	0.85	1	2	2	1	Term	1		1	2	1	1	1
2016/01/017112	27	6	1	1	1	1	1	1	2175	1.58	1.51	1.04	1	2	3	1	Term	1		1	1	1	1	1
2021/12/005239	24	7	2	1	3	1	1	1	2612	2.1	0.9	2.3	81	1	2	1	Term	1		1	2	2	1	1
2021/12/000343	29	3	1	1	2	1	1	1	1964	1.27	1.48	0.8	1	2	3	1	Term	2	3	1	2	1	1	1
2022/01/026355	33	3	2	2	3	1	1	3	1356	1.27	1.21	1.04	1	2	1	2	Preterm	2	1	1	2	2	1	1
2022/02/016519	28	1	2	3	4	1	1	1	2326	1.69	1.16	1.45	7	2	2	1	Term	1		1	1	1	1	1
2022/03/010013	28	3	2	2	1	1	3	1	2471	1.79	0.96	1.9	50	1	2	1	Term	1		1	1	1	1	1
2018/04/003822	32	1	2	2	4	3	3	1	2370	1.6	1.2	1.3	60	1	2	1	Term	1		1	2	1	1	1
2021/08/009335	29	7	1	1	1	1	3	1	3530	1.1	0.8	1.37	12	1	3	1	Term	2	3	1	1	1	1	1
2021/12/011681	22	1	1	3	4	1	2	1	2302	2.87	0.74	3.8	100	1	3	1	Term	1		1	2	1	1	1
2021/10/013254	26	1	2	1	4	1	3	1	2721	1.31	0.82	1.59	22	1	2	1	Term	1		1	1	1	1	1
2014/09/008643	29	1	2	3	4	1	3	1	3234	1.27	1.04	1.22	5	2	2	1	Term	1		1	1	1	1	1
2021/11/013795	36	6	2	1	1	2	2	1	2788	2.22	1	2.22	72	1	2	1	Term	1		1	1	1	1	1
2021/11/010550	28	3	2	1	3	2	1	1	2435	2.15	1.05	2.04	56	1	2	2	Term	3	1	1	1	1	1	1
2022/05/007245	29	7	2	1	1	1	1	3	2183	1.34	1.01	1.33	3	2	1	1	Preterm	2	3	1	1	1	1	1
2022/04/006153	28	1	3	3	5	1	1	1	2143	1.7	0.5	3.4	100	1	2	1	Term	1		1	1	1	1	1
2021/09/012043	28	5	3	1	3	1	1	1	2322	2	0.5	4	100	1	2	1	Term	1		1	1	1	1	1
2021/11/004375	28	1	2	2	3	2	1	1	2162	2.33	1.31	1.8	29	1	3	1	Term	2	2	1	1	1	1	1
2021/11/000037	22	1	2	2	3	1	3	1	2722	1.88	0.99	1.9	50	1	2	1	Term	1		1	1	1	1	1
2022/04/012506	33	1	3	2	4	>3	3	3	3174	0.84	1.45	0.58	1	2	2	1	Term	2	2	1	2	1	1	1
2021/04/013928	29	1	2	2	3	2	3	1	2514	1.3	1.6	0.8	1	2	3	1	Term	1		1	2	1	1	1
2021/12/000450	32	1	2	2	4	3	1	1	2508	1.42	0.83	1.71	25	1	2	1	Term	2	2	1	1	1	1	1
2022/03/015992	24	5	2	1	1	1	3	3	2110	2.27	1.15	1.9	56	1	2	1	Term	1		1	1	1	1	1
2022/05/001457	31	1	1	1	3	1	3	1	2345	1.48	1.08	1.37	7	2	2	1	Term	2	3	1	2	1	1	1
2021/11/017018	28	1	3	3	5	3	1	1	2252	1.46	0.97	1.95	46	1	2	1	Term	2	2	1	1	1	1	1
2022/05/000969	20	2	1	1	1	1	1	1	1652	0.8	0.9	0.89	1	2	3	1	Term	2	3	1	2	1	1	1
2022/01/029392	21	1	2	2	3	1	1	1	2055	2.11	0.94	2.24	72	1	2	1	Term	1		1	2	1	1	1
2017/07/004862	24	5	2	2	2	1	1	1	2683	1.9	0.9	2.1	61	1	3	1	Term	1		1	1	1	1	1
2019/02/001783	25	1	2	1	2	2	3	3	2665	1.28	0.78	1.67	30	1	3	1	Term	2	3	1	1	2	1	2
2021/01/017024	19	1	3	2	5	1	2	1	2729	1.91	0.84	2.27	67	1	2	1	Term	1		1	2	1	1	1
2022/02/013383	26	7	1	2	1	2	1	1	2540	1.5	0.83	1.91	34	1	2	1	Term	1		1	2	1	1	1
2021/11/009435	32	1	2	2	1	3	3	1	2350	1.07	0.62	1.77	29	1	2	1	Term	2	2	1	1	2	2	1
2020/11/007191	28	1	2	2	5	2	3	1	2312	1.1	0.7	1.6	14	1	2	1	Term	1		1	1	1	1	1
2022/02/022980	31	1	2	2	1	2	3	3	2953	1.66	0.72	2.3	81	1	2	1	Term	1		1	1	1	1	1
2022/04/016932	22	1	2	3	4	1	2	1	2852	2.4	0.85	1.7	96	1	3	1	Term	1		1	1	1	1	1
2022/06/004198	26	1	2	3	3	3	1	1	2531	1.5	0.8	1.96	48	1	1	1	Preterm	1		1	2	1	1	1
2019/10/016632	26	1	3	3	3	>3	1	1	2599	2	0.89	2.24	62	1	3	1	Term	1		1	1	1	1	1
2021/11/004532	24	7	1	1	2	1	3	1	3201	1.83	0.87	2.1	69	1	3	1	Term	1		1	1	2	1	1
2021/12/012312	28	1	2	3	1	3	1	1	1928	3.2	0.9	3.6	100	1	3	1	Term	1		1	1	1	1	1
2022/05/019062	22	1	2	2	3	1	3	1	3511	1.15	0.4	2.9	98	1	3	2	Term	1		1	1	1	1	1
2021/12/008861	26	1	2	2	4	1	1	1	2711	1.88	0.83	2.26	74	1	3	1	Term	1		1	1	1	1	1
2022/05/000969	20	1	2	3	3	1	1	1	2617	1.1	0.88	1.25	2	2	3	2	Term	3	3	1	2	1	1	1
2022/06/009781	22	1	2	2	1	2	3	1	2271	1.56	0.99	1.57	24	1	2	1	Term	1		1	2	1	1	1
2022/04/000494	30	6	1	1	2	2	2	1	2454	1.65	0.75	2.2	73	1	2	1	Term	2	3	1	1	1	1	1
2022/05/006607	24	1	2	3	4	2	1	1	2417	2.21	0.94	2.35	79	1	3	1	Term	2	2	1	1	1	1	1
2022/01/032330	24	1	2	3	3	>3	2	1	1951	1.4	1.52	0.9	1	2	1	3	Preterm	2	1	1	2	1	1	2
2022/02/002650	28	1	2	3	3	1	1	1	2334	1.84	0.79	2.33	78	1	2	1	Term	1		1	1	1	1	1
2017/12/000522	38	1	2	3	1	>3	1	1	2344	2.57	1.1	2.34	78	1	3	1	Term	2	2	1	1	1	1	1
2021/12/005943	24	1	3	3	5	1	2	1	2504	1.73	0.71	2.44	86	1	2	1	Term	1		1	2	1	1	1
2022/06/001784	21	1	2	2	1	1	3	1	3377	1.22	0.8	1.5	10	2	2	1	Term	2	3	1	1	1	1	1
2022/04/017481	30	1	2	2	4	>3	1	3	1991	2.82	1.16	2.43	83	1	1	2	Preterm	2	1	2	2	2	1	1
2022/05/019062	22	1	2	3	1	1	2	1	2840	1.47	0.76	1.93	51	1	3	1	Term	1		1	1	1	1	1
2022/04/002806	20	5	2	1	1	1	3	1	2288	1.35	0.76	1.7	40	1	2	1	Term	2	3	1	2	1	1	1
2021/11/013459	24	1	2	1	3	1	1	1	1869	1.6	1.26	1.26	3	2	2	1	Term	1		1	2	2	1	1
2022/05/008956	22	1	2	1	1	1	2	1	2184	1.07	0.88	1.21	3	2	2	3	Term	2	1	2	2	2	1	1
2022/03/008495	23	5	1	1	1	1	1	1	2046	1.56	0.95	1.64	7	2	2	1	Term	1		1	1	1	1	1
2021/05/006732	25	1	2	1	1	1	1	1	1713	1.62	1.17	1.38	3	2	2	1	Term	1		1	2	1	1	1
2022/03/019774	30	1	3	2	3	2	2	1	2484	1.34	1.04	1.28	4	2	3	1	Term	1		1	1	1	1	1
2022/01/033954	26	1	3	3	4	>3	1	1	1816	1.3	1.09	1.19	1	2	2	3	Term	1		2	2	2	2	1
2020/10/001952	24	1	2	1	2	1	2	1	2656	2.42	1	2.42	84	1	2	1	Term	1		1	1	1	1	1
2021/07/013271	27	7	2	1	2	1	3	1	3245	1.42	1.05	1.3	7	2	3	1	Term	2	3	1	1	1	1	1
2018/12/002803	28	1	2	2	2	1	3	1	2800	1.48	0.98	1.51	19	1	3	3	Term	2	1	1	1	2	1	1
2022/08/000764	27	1	2	1	3	1	2	1	2776	1.45	0.83	1.7	31	1	3	2	Term	2	1	2	1	1	1	1
2021/05/006534	26	6	2	1	1	2	1	1	2315	2.58	1.12	2.3	76	1	3	1	Term	2	2	1	1	1	1	1
2017/10/002856	32	1	2	2	1	2	1	1	2605	1.42	0.91	1.56	14	1	3	1	Term	2	2	1	2	1	1	1
2022/08/006159	30	1	2	1	1	1	2	1	1728	1.14	0.92	1.24	3	2	2	2	Term	2	3	1	2	1	1	1
2022/08/007283	26	1	2	1	1	2	1	1	1918	2.87	1.1	2.6	95	1	2	1	Term	1		1	2	1	1	1
2022/07/015156	21	1	2	2	3	1	1	1	2051	1.13	0.81	1.31	5	2	2	3	Term	2	1	1	2	2	2	1
2022/01/035732	25	1	2	1	1	1	3	1	2597	1.78	0.93	1.8	48	1	3	1	Term	1		1	1	1	1	1
2022/09/002245	28	1	2	2	5	3	1	1	1985	1.8	1.17	1.6	17	1	2	1	Term	1		1	1	2	2	1
2022/04/007423	25	1	2	2	1	1	3	1	2368	1.8	0.86	2	66	1	3	2	Term	1		1	1	2	2	1

MASTER CHART KEY

Variable	**Code**
Occupation:	
Housewife	1
Student	2
Doctor /nurse/paramedical	3
Laborer	4
Teacher	5
Engineer	6
Others	7
Socioeconomic status:	
Upper Middle class	1
Lower Middle class	2
Upper lower class	3
Education :	
Graduate	1
Higher	2
Senior secondary	3
Middle school	4
Primary	5
POG at USG :	
35-35+6 weeks	1

36-36+6 weeks	2
37-37+6 weeks	3
Liquor amount :	
Adequate	1
Polyhydramnios	2
Oligohydramnios	3
CPR centile :	
>10th centile	1
<10th centile	2
CTG:	
Reassuring	1
Non reassuring	2
Abnormal	3
Gestational age at delivery:	
35-36+6 weeks	1
37-38+6 weeks	2
>39 weeks	3
Type of delivery :	
Normal delivery	1
Cesarean section	2
Operative vaginal delivery	3
Indication of CS /operative vaginal delivery:	
Fetal distress	1
Previous LSCS not willing for TOLAC	2
Others	3

Meconium staining:	
No	1
Yes	2
Birth weight:	
>2.5 kg	1
<2.5 kg	2
APGAR at 1' :	
8-9	1
</=7	2
APGAR at 5':	
8-9	1
</=7	2
NICU admission:	
No	1
Yes	2