“SENSITIVITY OF UTERINE ARTERY DOPPLER IN THE PREDICTION OF PIH AND IUGR”

Dissertation submitted in partial fulfilment of the Requirement for the award of the Degree of

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TIRUNELVELI MEDICAL COLLEGE HOSPITAL

THE TAMIL NADU DR.M.G.R. MEDICAL UNIVERSITY
CHENNAI,
TAMIL NADU.
CERTIFICATE

This is to certify that the Dissertation entitled “SENSITIVITY OF UTERINE ARTERY DOPPLER IN THE PREDICTION OF PIH AND IUGR” submitted by Dr. DIVYA BHARATHI. K. MBBS., DGO., to The Tamilnadu Dr. M.G.R. Medical University, Chennai, in partial fulfillment for the award of M.S (Obstetrics and Gynaecology) is a bonafide work carried out by her under my guidance and supervision during the academic year 2013-2015. This dissertation partially or fully has not been submitted for any other degree or diploma of this university or other

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I, Dr. DIVYA BHARATHI. K. MBBS., DGO., solemnly declare that the Dissertation titled “SENSITIVITY OF UTERINE ARTERY DOPPLER IN THE PREDICTION OF PIH AND IUGR” has been prepared by me under the expert guidance and supervision of Prof. Dr. MUTHU PRABHA, MD (OG) Professor, Department of Obstetrics and Gynaecology, Tirunelveli Medical College Hospital, Tirunelveli.

This dissertation is submitted to the Tamilnadu Dr. M.G.R. Medical University, Chennai, in partial fulfillment of the regulations for the award of MS Degree Branch II (OBSTETRICS & GYNAECOLOGY).

It was not submitted to the award of any degree/diploma to any University either in part or in full previously.

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PROTOCOL TITLE: Sensitivity of uterine artery Doppler in the prediction of PIH and IUOR

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Dear Dr. K. Divya Bharathi, The Tirunelveli Medical College Institutional Ethics Committee (TIREC) reviewed and discussed your application during the IEC meeting held on 20.12.13.

THE FOLLOWING DOCUMENTS WERE REVIEWED AND APPROVED

1. TIREC Application Form
2. Study Protocol
3. Department Research Committee Approval
4. Patient Information Document and Consent Form in English and Vernacular Language
5. Investigator's Brochure
6. Proposed Methods for Patient Accrual Proposed
7. Curriculum Vitae of the Principal Investigator
8. Insurance /Compensation Policy
9. Investigator's Agreement with Sponsor
10. Investigator's Undertaking
11. DCGI/DOPT approval
12. Clinical Trial Agreement (CTA)
13. Memorandum of Understanding (MOU)/Material Transfer Agreement (MTA)
14. Clinical Trials Registry-India (CTRI) Registration

THE PROTOCOL IS APPROVED IN ITS PRESENTED FORM ON THE FOLLOWING CONDITIONS

1. The approval is valid for a period of 2 years or duration of project whichever is later
2. The date of commencement of study should be informed
3. A written request should be submitted 3 weeks before for renewal / extension of the validity
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5. The TIREC will monitor the study
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8. In the events of any protocol amendments, TIREC must be informed and the amendments should be highlighted in clear terms as follows:
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   b. The PI must comment how proposed amendment will affect the ongoing trial. Alteration in the budgetary status, staff requirement should be clearly indicated and the revised budget form should be submitted.
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INTRODUCTION

Pregnancy and child birth is a unique experience in women’s life. Every woman has her own expectation and emotions for delivering a healthy child.

The primary aim of antenatal care is to achieve at the end of
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ANNEXURE

i. PROFORMA

ii. MASTER CHART
LIST OF ABBREVIATIONS USED

SGA : Small for Gestational Age.
FGR : Fetal Growth Restriction.
HTD : Hypertensive Disorders of Pregnancy.
HZ  : Hertz.
KHZ : Kilohertz.
MHZ : Megahertz.
USG : Ultrasound.
SD  : Standard Deviation.
AC  : Abdominal Circumference.
HC  : Head Circumference.
TCD : Transcerebellar Diameter.
FL  : Femur Length.
EFW : Estimated Fetal Weight.
PI  : Ponderal index.
BP  : Blood Pressure.
HT  : Hypertension.
AFI : Amniotic Fluid Index.
BPP : Bio-Physical Profile.
NST : Non-Stress Test.
LBW : Low Birth Weight.
NHBPEP : National High Blood Pressure Education Programme.

PGE2 : Prostaglandin E2.

IUD : Intrauterine Death.

WKS : Weeks.

SLE : Systemic Lupus Erythematosus.

ACOG : American College of Obstetrics and Gynaecology.

NICU : Neonatal intensive care unit.

Sensi : Sensitivity.

Speci : Specificity.

PPV : Positive Predictive Value of the test.

NPV : Negative Predictive Value of the test.

LR Positive test : Likelihood Ratio for Positive Test.

LR (-) test : Likelihood Ratio for Negative Test.

H/O : History of

FP : Percentage of False Positive.

FN : Percentage of False Negative.

TP : True Positive.

TN : True Negative.

PI : Pulsatility Index.

RI : Resistance Index.

PIH : Pregnancy induced hypertension.

IUGR : Intrauterine Uterine Growth Restriction.
DV : Ductus Venosus
SBP : Systolic Blood Pressure.
DBP : Diastolic Blood Pressure.
INTRODUCTION

Pregnancy and child birth is a unique experience in women’s life. Every woman has her own expectation and emotions for delivering a healthy child.

The primary aim of antenatal care is to achieve at the end of pregnancy, a healthy mother and a healthy baby. Recently there have been many modern investigative and treatment modalities to provide a good health care. Despite advances in antenatal care, hypertensive disorder in pregnancy contributes to increased maternal morbidity and mortality and thereby accounts for increased perinatal morbidity and mortality.

Major cause of maternal mortality according to 2001-2003 SRS survey are Hemorrhage (38%), sepsis (11%), hypertension (5%), obstructed labour (5%), abortion (8%), and other conditions (34%).

Main pathophysiology in preeclampsia and fetal growth restriction is impaired uteroplacental and fetoplacental circulation respectively.

Pathophysiology in preeclampsia is absence of secondary wave of trophoblastic invasion into spiral arterioles at deciduo - myometrial invasion. So the muscular tissues in the tunica media layer is not
destroyed leading to persistence of high resistant vessels, leading to decreased uteroplacental circulation.

Colour Doppler ultrasound of uterine artery at 20-22 weeks of gestation showing persistent diastolic notch helps in predicting pregnancy induced hypertension and intrauterine growth restriction.

Normally the early diastolic notch persists till 22 weeks after which there will be disappearance of diastolic notch. Persistence of diastolic notch beyond 22 weeks indicates defective placentation.

The study is conducted to predict pregnancy induced hypertension and intrauterine growth restriction by using uterine artery Doppler and thereby to follow up the risk patients and to reduce both maternal and perinatal morbidity and mortality.
AIM OF THE STUDY

To find out the sensitivity of uterine artery doppler in prediction of pregnancy induced hypertension and intrauterine growth restriction at 20-22 weeks of gestation thereby to follow up the at risk patients and to improve perinatal outcome.
REVIEW OF LITERATURE

Fetal growth restriction

Fetus with estimated weight below the 10\textsuperscript{th} percentile for a given gestational age, due to a pathologic process that inhibits intrinsic growth potential\textsuperscript{(1,2)} is called fetal growth restriction\textsuperscript{.}(ACOG-2000\textsuperscript{)}\textsuperscript{3}).

Small for gestational age and fetal growth restriction are frequently used to describe the small fetus. About 50%-70\% of small-for-gestation fetuses are constitutionally small but healthy. 20\% of SGA fetuses are classified as having true FGR, associated with chromosomal anomalies, chronic infections. In fetal growth restriction there is a pathological restriction of growth both in cell size and number.

INCIDENCE

10\% in developing countries\textsuperscript{(4)}.

5-7\% in developed countries.

RISK FACTORS FOR FGR

* Extremes of reproductive age (younger than 16yrs and older than 35 yrs).

* Poor maternal weight gain.

* Poor pre-pregnancy weight.

* Severe malnutrition.
* low socio-economic status
* Maternal medical conditions
  * hypertension
  * Renal disease
  * Diabetes (with microvascular disease)
  * Cyanotic heart disease
  * Antiphospholipid syndrome
  * collagen vascular disease
  * Hemoglobinopathies
* Chromosomal anomalies
* Structural anomalies
* primary placental disease
* Infections
* exposure to teratogens.

ETIOLOGICAL FACTORS IN FGR

* Placental causes 80%
* Maternal disease 5%
* Fetal chromosomal anomalies 5%
* Fetal infections 5%
* Multifactorial fetal abnormalities 2-4%
TYPES OF FGR

TYPE 1 or Symmetric FGR- Intrinsic FGR

- Fetuses that are symmetrically small and have normal H/A and F/A ratios. Defect is in the fetus.
- Causes-chromosomal abnormalities, viral infections.
- Prognosis-poor.

TYPE 2 or asymmetric FGR-extrinsic FGR

- Fetuses are initially symmetric but become asymmetric later in pregnancy.
- Causes-uteroplacental disease, maternal disease.
- Prognosis-good.

ETIOPATHOGENESIS OF FGR

Placental causes

Most common cause

1. Incomplete trophoblastic invasion of the spiral arteries in the placental bed.
2. Accelerated atherosclerosis of spiral arteries.
3. Increased no. of syncitial knots, obliteration of arteries in tertiary stem villi, stromal fibrosis.
4. Placental infarction and thrombosis due to factor V leiden mutation and antiphospholipid syndrome.
5. Chronic villitis, hemorrhagic endovasculitis, placental mosaicism. Lymphocytic and histiocytic infiltration of villi are markers of chronic villitis.  

**FETAL CAUSES**

- Chromosomal abnormalities especially trisomy 18.
- Viral infections like congenital rubella, cytomegalovirus, varicella, HIV, Herpes simplex virus.
- Osteogenesis imperfecta.
- Multiple pregnancy, heart diseases.

**MATERNAL CAUSES**

- Chronic hypertension
- Chronic renal disease
- Diabetes
- Preeclampsia
- Grade 3,4 heart disease
- Smoking, alcohol, tobacco chewing.
- SLE
- Fever, sickle cell anemia, malnutrition.
UTERINE CAUSES

- Bicornuate uterus, didelphis uterus.
- Fibroid uterus.

FETAL AND NEONATAL PROBLEMS WITH FGR

Complications

* Antepartum complications
* Intrapartum complications
* Neonatal complications

Antepartum complications

* Fetal hypoxia, acidosis
* Still birth
* Oligohydramnios.

Intrapartum complications

* Hypoxia, acidosis.

Neonatal complications

* Respiratory distress syndrome
* Meconium aspiration syndrome
* Persistent fetal circulation
* Intraventricular bleeding, more in preterm FGR\(^6\)
* Hypoglycemia
* Neonatal encephalopathy
* Hyperviscosity syndrome
* Hypocalcemia
* Hypothermia

**Long term prognosis**

* Cerebral palsy
* Adult disease like diabetes, hypertension, coronary heart disease.

In newborns affected by FGR there is increased risk of HT, DM, ischemic heart disease.(7,8,9)

**ANTENATAL DIAGNOSIS OF FGR**

- Recognition and confirmation of FGR
- Identification or exclusion of pathological conditions

**Assessment of risk factors**

- Presence of risk factors like preeclampsia, maternal hypertension, lupus erythematosus, IDDM with vascular disease, cyanotic heart disease.
- Previous birth of a FGR infant.
- Medications like anticonvulsants, warfarin, antineoplastic agents.
- Low PAPP-A in first trimester screening, elevated levels of HCG,
inhibin, AFP in triple or quadruple screening is associated with a five-fold increase in FGR when the fetus is unaffected by trisomy or neural tube defects. (Gagnon et al, 2008) 

- Notching or increased Pulsatility index in 1st and 2nd trimester is associated with increased risk of FGR.

**PHYSICAL EXAMINATION**

Discordance between gestational age and symphysio - fundal height >4 cm. Symphysio-fundal height measurements are helpful, but not sensitive in detecting FGR (Harding, 1995) 

These indicators, combined with maternal history and risk factors serve to indicate additional ultrasound evaluation.

**USG PARAMETERS**

- Biparietal diameter.
- Head circumference.
- Abdominal circumference.
- Femur length.
- Estimated fetal weight.

Women with negative uterine doppler screening are at low risk of FGR (Negative predictive value of 97% - 99%) and can be followed as normal pregnancies.
UTERINE ARTERY DOPPLER SCREENING

Presence of bilateral diastolic notch in uterine arteries is the predictor of FGR.

DIAGNOSIS

It depends on

➢ Correct estimation of gestational age, preferably in the 1st trimester.
➢ Gestational age based on LMP using Naegeles rule is uncertain in 20%-40% of cases.
➢ Gestational age is best established in 1st trimester using CRL measurement. Predictive error of EDD based n CRL is 7 days.

USG PARAMETERS

HC/AC RATIO

➢ It compares the most preserved organ (brain) with the most affected organ (liver).
➢ HC/AC is normal in symmetric FGR.
➢ HC/AC is increased in asymmetric FGR, >95% percentile for gestational age.
➢ Normally HC/AC ratio is >1 upto 36 weeks. After 36 weeks the value of HC/AC ratio is <1 (12).
➢ Head circumference is measured at the level of thalami. Abdominal circumference is measured at the level of bifurcation of hepatic
vein in the center of fetal liver.

- An abdominal circumference within normal range reliably excludes FGR with false negative rate of <10%.
- AC and estimated fetal weight <10% centile are the most accurate diagnostic measurements to predict FGR.

**GESTATIONAL AGE IS UNCERTAIN**

Following parameters are used

- **Trancerebellar Diameter / Abdominal Circumference Ratio.**
  - The distance between the outer borders of the cerebellum is not affected in FGR.
  - The normal TCD/AC ratio is $0.137 \pm 0.01$.
  - TCD in cm = gestational age in weeks up to 32 weeks.

**FEMUR/ABDOMINAL CIRCUMFERENCE RATIO**

- Femur length is least affected by FGR and by position or moulding.
  - F/A ratio is constant at $22 \pm 2$ after 20 weeks.
  - Increased F/A ratio suggests FGR.

**PONDERAL INDEX (PI)**

- PI remains constant after 2nd trimester
  - $PI = \frac{EFW}{(FL)^3 \times 100}$
Normal value is 8.325 ± 2.5

If PI is <= 7 it is FGR.

PI has negative predictive value of 96.4%

GROWTH CHARTS

* Serial ultrasounds at intervals of two to four weeks for evaluation of fetal growth with the use of standardised growth curves demonstrate growth velocity.

* Decreased growth velocity is an important indicator of FGR.

* Suspect FGR when AC deviates 10% or more from the individual projected growth curve.

AMNIOTIC FLUID VOLUME (AFI)

1. AFI is important both in diagnosis and prognosis for FGR.

2. Oligohydramnios is highly suggestive of FGR and indicates increased risk of Perinatal mortality.

3. About 77%-83% of pregnancies with FGR will have oligohydramnios ultrasonographically. (Philipson et al1983) (14,15).

4. AFI is normal even in a fetus with FGR. Therefore absence of oligohydroamnios does not rule out the diagnosis of FGR. As a rule of thumb, pregnancies with the most severe oligohydramnios have the highest perinatal mortality rate, highest incidence of congenital anomalies and FGR.
MANAGEMENT

1. Confirm the diagnosis
2. Exclude fetal anomalies
3. Treat the underlying cause
4. Fetal surveillance
5. Treatment for FGR

EXCLUDE FETAL ANOMALIES AND UNDERLYING CAUSE

Chromosomal defects and multifactorial congenital malformations 20 to 30% of fetus with an AC and EFW less than fifth percentile have chromosomal defects and multifactorial congenital malformations. The percentage is much higher if FGR is diagnosed before 26 weeks of gestation and associated with polyhydramnios\(^{(11)}\)

Structural abnormalities

A detailed anatomical ultrasound survey must be done to rule out structural abnormalities. It may also be appropriate to offer karyotyping in early onset FGR (Snijders,1993) \(^{(16)}\).

Fetal infections

Infections that develop early in pregnancy have the greatest effect on subsequent growth, but account for less than 5% of FGR.
Multiple gestations are associated with both preterm delivery and FGR.

Maternal vascular disease with its associated decrease in uteroplacental perfusion accounts for 20% of FGR. It is the most common cause for FGR in non anamalous fetus\(^{17}\).

**Fetal surveillance**

1. The goal of antepartum surveillance in FGR is to safely continue the pregnancy and intervene when the intrauterine environment is hostile to the fetus.

2. Antepartum surveillance with doppler of the umbilical artery and MCA is initiated when FGR is suspected and the fetus is viable.

3. Antepartum surveillance aims to
   a. Identify small, yet healthy, fetuses and support these pregnancies appropriately.
   b. Identify FGR fetus at risk and intervene appropriately.

**UMBILICAL ARTERY DOPPLER**

- Umbilical artery doppler helps to differentiate a normal SGA fetus from the FGR fetus.

- Indices of umbilical artery doppler waveforms such as resistance index.

- Systolic/ diastolic ratio and pulsatility index are useful for
predicting perinatal outcome.

- Umbilical artery doppler waveform is considered abnormal if diastolic flow is reduced, absent or reversed after 20 weeks gestation.

- Absent or reverse flow in umbilical artery is associated with 60 to 70% obliteration of placental arteries and high perinatal mortality. (Kingdom 1997)\(^{(18)}\)

Abnormal umbilical artery indices are strong predictors of poor perinatal outcomes like

- Low APGAR score
- Late deceleration
- Severe variable decelerations
- Absent variability
- Low fetal scalp pH
- Presence of thick meconium
- Admission to NICU
Clinical significance of umbilical artery doppler in FGR

* When an anomaly scan and umbilical artery doppler are normal and the liquor is adequate, the small fetus is likely to be a normal small fetus.

* Outpatient management with frequent monitoring of such fetus is safe.

* Abnormal umbilical artery doppler is an indication for enhanced fetal surveillance or delivery.

MIDDLE CEREBRAL ARTERY DOPPLER

➤ Umbilical artery doppler waveforms in isolation are unsuitable as a test for fetal well being. They do not reflect fetal responses or placental insufficiency accurately to predict perinatal outcome.

➤ Fetal hypoxemia causes cerebral vasodilation - “brain sparing” effect. Redistribution of cardiac output occurs with increased blood flow to the brain, heart, adrenals and reduced flow to kidneys and muscles.

➤ Reduced Pulsatility index in the MCA doppler suggests redistribution of blood to the brain.
DOPPLER OF THE VENOUS SYSTEM

➢ Doppler studies of the venous circulation are indicated when FGR fetus shows brain redistribution.

➢ Umbilical vein can be screened.

➢ Ductus venosus (DV) is identified as the aliasing point at the top of the intrahepatic vein. Progressively deep a-wave in the ductus venosus is an indicative of right heart strain in the fetus and correlate with fetal acidosis at delivery.

Typical progression of multi-vessel doppler studies with progressive placental dysfunction in FGR.

- Elevated umbilical artery S/D ratio.
- MCA PI<5\text{th percentile}(brain sparing).
- Umbilical artery-absent diastolic flow.
- Umbilical artery-reversed diastolic flow.
- Ductous venosus-elevated PI.
- Ductous venosus-reversed a-wave.
- Umbilical vein double pulsations.
- Umbilical vein triple pulsations with reversed a-wave.
INTEGRATED FETAL TESTING

Baschat (2003)\textsuperscript{(19)} has suggested multiple testing to monitor FGR

- Periodic fetal biometry
- AFI
- Multi vessel arterial and venous doppler.
- Biophysical profile (BPP).
- Fetal heart rate monitoring (CTG).
- Fetal movement counting.

TREATMENT

No effective therapies for FGR available.

BED REST

The idea behind this is that blood flow to placenta increases. But Laurin and Person conducted randomised control trial and said that there is no role in bed rest\textsuperscript{(20)}

HYPOXIGENATION

Nicolaides et al\textsuperscript{(21)} and Battagia\textsuperscript{(22)} et al found decrease in fetal mortality when mother is exposed to oxygen.

ASPIRIN

Aspirin inhibits thromboxaneA2 and changes thromboxane to prostacycline. It causes vasodilation in uteroplacental circulation and thereby decreases the incidence of FGR and preeclampsia\textsuperscript{(23)(24)}.  

19
OPTIMAL TIME OF DELIVERY

* FGR fetus is chronically hypoxemic. Continued intrauterine hypoxia leads to metabolic deterioration.

* Fetus should be delivered if the risk of fetal death increases. ACOG (2000)(3).

* A fine balance needs to be made between prematurity and intrauterine hypoxia (GRIT STUDY-2003)(25).

* Growth restriction intervention trial concluded that if the fetus is at <31 weeks gestation, it is best to delay delivery(26).

DETERMINANTS OF TIMING OF DELIVERY OF FGR FETUS

- Etiology of FGR
- Biophysical profile
- Non stress test
- Fetal movement
- AFI
- Doppler velocimetry
- Interval growth
- Gestational age
- Maternal co-morbidities
MANAGEMENT BASED ON GESTATIONAL AGE

BEFORE 26 WEEKS

❖ Outcome is extremely poor in view of extreme prematurity and FGR.
❖ Delivery is indicated only for maternal indications like severe preeclampsia
❖ Survival is <50% and the long term handicap is around 30-50%
❖ Option of non intervention and probable IUD should be given in the absence of maternal disease and risk.

26-28 WEEKS

❖ Administer steroids to enhance lung maturity.
❖ Monitor fetus for signs of worsening hypoxia
❖ Decision to deliver depends on the intensive care for these babies.

28-31 WEEKS

❖ Risk of perinatal mortality is high due to prematurity, Doppler studies of the ductus venosus may be used to assist in decision making.
❖ Normal flow in ductus venosus may allow extension of pregnancy to 32-34 weeks if other tests of wellbeing remain reassuring.
❖ Administer two doses of steroids before delivery.
32-36 WEEKS

- Risk of respiratory distress syndrome is reduced.
- A primary factor that should be considered after 34 weeks of gestation is the risk of fetal death. Late onset FGR contributes to >50% of unanticipated stillbirths at term.

MODERATE FGR

- Consider induction of labour if the fetus is > or =36 weeks of gestation age.
- Delivery can be delayed until after 37 weeks in the presence of normal diastolic flow in the umbilical artery and other surveillance findings being normal.

SIGNIFICANT GROWTH RESTRICTION

Consider delivery if imminent signs of fetal compromise as

- Non-reactive NST
- Poor baseline variability
- Persistent variable or late decelerations are present.

>36 WEEKS

- Consider delivery in FGR with oligohydramnios >36 weeks
- Induction of labour with careful fetal monitoring is important as these fetuses will not tolerate acute hypoxia.
DIGITAT (Disproportionate Intrauterine Growth Intervention Trial At Term) study showed no difference in perinatal outcomes, if after 36 weeks’ delivery was by induction of labour or by expectant management. (Boers, 2010)\(^{(27)}\)

**MODE OF DELIVERY**

Due to increased prevalence of chronic hypoxia and oligohydramnios among FGR, the rate of cesarean section will increase.

**Indications for cesarean section**

- Severe FGR with EFW <1.5 kg
- Preterm FGR <32 Weeks
- Non-reassuring fetal heart rate
- Metabolic acidosis and
- Other obstetric indications.

During labour perform continuous intrapartum fetal monitoring to detect non-reassuring fetal heart rate indicating progressive hypoxia and provide intensive neonatal care.

**RECURRENT RISK FOR FGR**

Risk of FGR in 2nd pregnancy is 29% and the risk in third pregnancy rises to 44% after two FGR (Bakketeig and Hoffman, 1983)\(^{(28)}\).
HYPERTENSIVE DISORDERS OF PREGNANCY

Hypertensive disorders in pregnancy is the major cause of maternal death all over the world. A diagnosis of hypertension in pregnancy increases a woman’s risk of developing chronic hypertension and cardiovascular problems. It increases the risk to the baby in the form of still birth, preterm birth and FGR.

DEFINITIONS

According to National High Blood Pressure Working group (NHEPEP) and ACOG, hypertension in pregnancy is defined as systolic blood pressure >140mm of Hg and diastolic blood pressure >90mm of Hg in a previously normotensive woman after 20 weeks of gestation on two occasions 4-6 hours apart.

Diastolic blood pressure is the disappearance of sounds (Kortkoff Phase V). Blood pressure should be measured in sitting or in left lateral position with the arm at the level of heart. An appropriately sized cuff (length 1.5 times the circumference of the arm) should be used. If BP is high in one arm, the arm with the higher value should be used for all BP measurements.
CLASSIFICATION OF HYPERTENSIVE DISORDERS

➢ GESTATIONAL HYPERTENSION: It refers to elevated blood pressure, first detected at 20 weeks of gestation, in the absence of proteinuria or other features of preeclampsia.

➢ PREECLAMPSIA: It refers to the syndrome of new onset of hypertension and proteinuria, often after 20 weeks of gestation, in a previously normotensive woman. Edema and weight gain excluded from the criteria.

➢ ECLAMPSIA: convulsions occurring in a patient with preeclampsia. It can occur with hypertension or proteinuria.

➢ CHRONIC HYPERTENSION: It is defined as systolic pressure >140/90 mm of Hg and >90 mm of Hg that antedates pregnancy, or it is before 20 weeks of pregnancy or persists beyond 12 weeks post partum.

➢ PREECLAMPSIA - ECLAMPSIA SUPERIMPOSED UPON CHRONIC HYPERTENSION: This is diagnosed when a women with chronic hypertension develops increasing hypertension with new onset proteinuria or features of preeclampsia (elevated liver enzymes, low platelet count).
• Mild gestational hypertension is SBP 140-159mm of Hg and DBP 90-109 mm of Hg.
• Severe GHT is SBP >= 160 mm of Hg and/or DBP >= 110 mm of Hg.
• White coat hypertension is DBP >= 90 mm of Hg in office, but <135/85 mm of Hg at home (Pickering et al).

➢ HELLP syndrome: Includes
  • Hemolysis
  • Elevated liver enzymes
  • AST > 70 U/L
  • LDH > 600 U/L
  • Thrombocytopenia (<1 lakh mm3)

PROTEINURIA

* 15-25% of gestational hypertension progress to preeclampsia.

Urine dipstick testing is performed on a fresh, clean voided, specimen before pelvic examination.

RESULTS

❖ Negative
❖ Trace
❖ 1+ = between 30 and 100 mg/dl
2+ = between 100 and 300 mg/dl
3+ = between 300 and 1000 mg/dl
4+ = > 1000 mg/dl
Proteinuria > 2+ is significant
Proteinuria > 1+ should be followed by mid-stream urine culture to rule out infection and to check for significant proteinuria.
24-hr urine collection is the gold standard to quantify protein >= 300 mg/d in 24 hr urine collection is significant proteinuria. Now-a-days 24-hour test is replaced by spot urine protein creatinine ratio. (Durnwald and MERCER,)

INCIDENCE
- 6-15% Nullipara
- 2-4% multipara²⁹,³⁰

RISK FACTORS
- Young age.
- Nullipara
- Race
- Environmental factors
- Maternal > 35 yrs
- Multiple pregnancy
- Molar pregnancy
Smoking decreases risk of Preeclampsia(1)

HIGH RISK FACTORS

- Previous preeclampsia
- Antiphospholipid antibody syndrome.
- Preexisting DM, HT.
- Women with SLE.
- Chronic renal disease.

MODERATE RISK FACTOR

- Multiple pregnancy.
- Primi
- Maternal age >40 yrs.
- BMI>35 kg/m2
- Family history of preeclampsia.
- Interpregnancy interval >10 yrs.

ETIOPATHOGENESIS OF PREECLAMPSIA

- Increased risk of preeclampsia in women exposed to chorionic villi for first time.
- Hyperplacentosis (abundance of chorionic villi-twins, mole)
- Genetic predisposition
- Abnormal trophoblast invasion
- Immunological maladaptation to inflammatory changes\textsuperscript{(1)}
- Calcium and magnesium deficiency\textsuperscript{(35)}

**NORMAL PLACENTATION**

Initially 4 weeks after implantation of fertilized ovum low resistant vessels are seen in the future placenta\textsuperscript{(31)}

At 10-12 weeks, first wave of trophoblast invasion occur upto decidual segments.

At 16 weeks, second wave of extravillous trophoblasts invasion of spiral arterioles occurs upto inner third of myometrium\textsuperscript{(32)} , thereby the musculoelastic and neural tissue element in the spiral arterioles are destroyed converting high resistant vessel into low resistant high flow vessels.

In preeclampsia, there is failure in second wave of trophoblastic invasion. So musculoelastic media of spiral arterioles remain intact and respond to vaspressor agents\textsuperscript{(32)}

Placental bed biopsies in preeclampsia-necrotising lesion with foam cells in spiral arteries (acute atherosis)\textsuperscript{(33)}\textsuperscript{(34)}. 
CANDIDATE GENES

Polymorphisms of FAS, hypoxia-inducible factor-1 alpha protein, IL-1 beta, lymphotoxin-alpha, TGF-beta, TNF could be the cause of preeclampsia. (35)

ENDOTHELIAL ACTIVATION

- Activated lymphocytes in maternal placental debris is responsible for endothelial cell activation.
- Cytokines like IL, TNF alpha are associated with preeclampsia.
- Other factors like
  - Intense vasospasm
  - Increased pressor responses to angiotensin 2
  - Prostacycline : thromboxane ratio decreases
  - Decreased nitric oxide
  - Increased endothelin (35)

ANGIOGENIC AND ANTIANGIOGENIC PROTEINS

- Soluble FMS- like tyrosine kinase 1 (sflt-1) is a variant of flt-1 receptor for placental growth factor and vascular endothelial growth factor.
- Increased maternal sflt-1 inactivate and decrease VEGF and PIGF leading to endothelial dysfunction (35)
Soluble endoglin (sEng) is a placenta derived molecule that block endoglin, thereby decrease NO dependent vasodilatation\textsuperscript{(35)}.

**PATHOPHYSIOLOGY**

- Endothelial cell damage leads to fluid leakage into the third space. This leads to decreased intravascular volume and hemoconcentration.
- Liver edema and hepatocellular damage increases LDH and serum transaminase levels. Stretching of Glissons capsule leads to epigastric pain, and sometimes hepatic hemorrhage.
- Vasospasm and glomerular endotheliosis lead to decreased renal blood flow and GFR. Glomerular demage leads to proteinuria. Persistent oliguria leads to acute tubular necrosis and ARF.
- Cerebral hypoxia results in headache, scotoma, blurred vision and hyperreflexia. Cerebral hemorrhage and stroke occurs in severe cases.
- Endothelial damage leads to coagulation cascade activation and DIC.
- Thrombocytopenia occurs due to microangiopathy.
Etiopathogenesis of pre-eclampsia
Normal and Abnormal Placentation

Angiogenic and antiangiogenic factors in pre-eclampsia

33
Pathophysiology and Complications of Pre-eclampsia

Genetic factors

Immunological factors

others

Failed maternal remodeling
> Impaired trophoblastic invasion of the spiral arteries

Defective placental implantation
> Placental underperfusion

Placental Hypoxia/ischemia

Pro-angiogenic factors
- VEGF
- PIGF

Anti-angiogenic factors
- sFlt-1
- sEng
- NGAL

Imbalance

Maternal endothelial dysfunction

Clinical symptoms of preeclampsia

Hypertension

Proteinuria

Liver dysfunction

Cerebral edema

I. Intrauterine Growth Restriction
II. Small for Gestational Age
III. Oligohydramnios (Fetal)
INVESTIGATIONS

★ Urine analysis-proteinuria
★ Hb-raised (hemoconcentration, except in hemolysis)
★ Platelet-low.
★ Peripheral smear-schistocytes.
★ INR and APTT-higher in DIC.
★ Serum creatinine-higher
★ ALT,AST,LDH-higher
★ Albumin-lower
★ Bilirubin –higher.
★ FUNDUS examination.

MANAGEMENT OF HYPERTENSIVE DISORDERS IN PREGNANCY

Pre-conceptional advice

1. Women with preexisting hypertension should have an of the medication they currently take.

2. Angiotension converting enzyme inhibitors, atenalol, statins, thiazides have an adverse effect on fetus, so discontinue the drug.

3. According to NICE guidelines, women with atleast one high and two moderate risk factors of preeclampsia should be given 75mg of
aspirin daily, from 12 weeks of pregnancy till the delivery of the baby. (36)

4. Investigations like serum potassium, creatinine and urine analysis should be done prior to woman with history of chronic hypertension.

TREATMENT OF HYPERTENSION

* Aim to maintain BP <150/100 mm of Hg. Overzealous treatment of hypertension should be avoided. In patients with DM, systolic BP should be maintained between 130 mm of Hg-139 mm of Hg. Diastolic BP between 80-89 mm of Hg.

* SOGC guidelines (2008)(37) suggest that
  
  * Women with mild-moderate HT and without co-morbid conditions should have antihypertensive to lower DBP to 80-105 mm of Hg.

  * Hypertensive women with co-morbid conditions like DM, chronic HT and renal disease should have systolic BP 130-139 mm of Hg and DBP of 80-89 mm of Hg.

  * In patients with severe HT maintain SBP of 140-150 mm of Hg and DBP of 90-100 mm of Hg.
DRUGS

* Labetalol.
* Nifedepine.
* Alpha methyl dopa

NICE recommends Labetalol as first line medication. But avoid labetalol in asthmatic patients.

- LABETALOL 100-400 mg bd-tds (maximum of 1200mg/d) side effects - Postural hypotension, tiredness.
- METHYLDOPIA 250-500 mg tds-qid (maximum of 2g/d) side effects - headache, dizziness, hypotension, headache.
- NIFEDEPINE- 10-20mg bd S.E- hypotension, headache and nasal congestion.

CORTICOSTEROIDS

- Women with preeclampsia before 34 weeks should have steroids for fetal lung maturity.
- 12mg of betamethasone given IM 24 hrs apart, 2 doses.(RCOG-2010).^{38}

PREDICTION^{35}

- Placental perfusion – roll over, isometric hand grip, midtrimester mean arterial pressure and uterine artery doppler.
Fetal-placental unit - endocrine dysfunction - HCG, Alpha fetoprotein, estriol, PAPP-A, inhibin-A, activin-A, placental protein-13, corticotropin releasing hormone.

RENAL DYSFUNCTION- serum uric acid, microalbuminuria, urinary calcium or Kallikrein, microtranferrinuria, N-acetyl beta glucosaminidase.

Endothelial dysfunction-platelet count, fibronectin, endothelial adhesion molecule, prostaglandin, CRP, PAI, leptin, PIGF, sflt-1.

Miscellaneous-Antithrombin-III, Atrial natriuretic peptide, beta2-microglobulin, serum proteonomics markers.

TIMING OF DELIVERY (according to ACOG )

- 38-39 weeks of gestation for women not requiring medication.
- 37-39 weeks for women with controlled hypertension with medication.
- 36-37 weeks with severe hypertension.
- HYPITAT (Hypertension and Preeclampsia Intervention Trial At Term (Koopmans et al, 2009)(39) shows that the outcome of pregnancy with gestational HT induced at >37 wks was better compared to expectant management.
**INTRAPARTUM CARE**

- Vaginal delivery should be considered except for obstetric indications.
- Steroids should be given when gestational age <34 weeks.
- In case of poor Bishops score, induction should be done with prostaglandins.
- In case of FGR and oligohydramnios, intrapartum monitoring should be done.
- During labour, hourly BP monitoring should be done. Maintain BP<160/110 mm of Hg.
- During labour, continuous fetal monitoring should be done.
- If BP is controlled, second stage of labour need not be cut short routinely.
- Avoid ergometrine during third stage of labour. Active management of third stage of labour should be followed.

**MANAGEMENT OF SEVERE PREECLAMPSIA**

Clinical features of severe preeclampsia includes:

- Severe headache
- Vomiting
- Epigastric pain
- Visual disturbances
* Papilledema
* Oliguria
* Thrombocytopenia
* Elevated liver enzymes.
* HELLP syndrome.

CHOICE OF DRUGS

Labetalol is the first line of drug. It can be given both orally and intravenously. Due to beta receptor blocking activity, it is better to avoid in asthmatic. Labetalol causes neonatal hypoglycemia and bradycardia.

OTHER DRUGS IN USE ARE

- Nifedepine
- Hydralazine
- Avoid sublingual nifedepine to reduce BP in patient with volume depletion, since it will cause precipitous fall in BP. (NICE, 2010).
- Antidote for Mgso4 toxicity is 10 g of 10% calcium gluconate given IV.

- Labetalol 20mg IV bolus followed by 40 mg if not effective within 10 minutes then, 80mg every 10 mins, max dose 220mg.
- Nifedepine-10mg orally every 30 mins, max of 3 doses.
- Hydralazine- 5-10mg IV every 15-20 minutes.
DELIVERY OF PATIENT WITH SEVERE PREECLAMPSIA

- In case of severe preeclampsia, delivery at 34-36 weeks to be considered. (Magloire and Funai, 2013)\(^{(40)}\)
- Prophylactic Mgso4 should be given.
- The only proven treatment of preeclampsia is delivery of the baby.

SEIZURE PREVENTION

- Magnesium sulphate is the drug of choice for treatment of eclampsia, according to MAGPIE and Collaborative Eclampsia Trial)\(^{(41)}\)
- PRITCHARD regimen- 4g iv over 3-5 mins followed by 10 g deep im (5g in each buttock).
- Management during fit: A mouth gag is placed in between teeth to prevent tongue bite and remove the gag after clonic phase.
- Head to be turned to one side, air passage to be cleared of mucus.
- Nasal o2 is given until cyanosis disappears.

Pathophysiology of eclampsia

Loss of cerebral autoregulation leads to either vasodilation or intense vasospasm of cerebral arteioles. Cerebral vasoconstriction leads to ischemic cytotoxic edema and infarction. When the autoregulation fails, vasodilation occurs leading to hyperfusion and vasogenic edema. (Sibai BM, 2005). CT shows hemorrhage and infarction in 50% of
eclamptic women. (Brown CEL ,1998). Visual disturbances occur due to retinal detachment or occipital lobe lesions and often it is reversible.

**HELLP SYNDROME**

- The diagnosis is based on laboratory criteria (Tennessee classification):
  - Microangiopathic hemolytic anemia – schistocytes and burr cells in peripheral smear.
  - Increased serum bilirum > 1.2 mg /100ml
  - Elevated LDH >600 U /L
  - Platelet count <1 lakh/mm3.
  - Serum AST (SGOT) >70 IU/L

- Symptoms are vague and lead to delay in diagnosis. Typical symptoms are nausea, vomiting, right upper quadrant pain.

- HELLP may manifest even in the absence of HT.

- Maternal complications of HELLP occur in the form of DIC, pulmonary edema and renal failure.

**Differential diagnosis for HELLP syndrome:**

- Acute fatty liver of pregnancy (AFLP)
- Idiopathic thrombocytopenic purpura.
- Thrombotic thrombocytopenic purpura.
- Lupus flare.
- Hemolytic uremic syndrome.
MANAGEMENT OF HELLP SYNDROME

✓ Termination of pregnancy is ideal.

✓ For successful outcome, multidisciplinary management is important.

✓ If platelet count is <20000, give platelet transfusion.

✓ Role of steroids and plasmapheresis in HELLP is not clear.

RISK OF RECURRENCE

★ Risk of recurrence of gestational hypertension - 15-50%.

★ Women with previous history of preeclampsia, eclampsia, HELLP, risk of recurrence in future pregnancy is 25%(if delivery occurs before 34 weeks).

★ The risk increases to 55% if previous delivery occurs prior to 28 weeks). (NICE, 2010)

DOPPLER STUDY

➢ It is a non-invasive technique that uses high frequency sound waves to detect blood flow.

➢ Study was based on Doppler Effect (42). Doppler effect was discovered by Christopher Doppler in 1942.
DOPPLER PRINCIPLES AND VELOCITY MEASUREMENTS

The ultrasound scanner transmits pulses to detect movement of blood. Echoes from stationary tissues are same from pulse to pulse and for moving objects light differences exhibits in the time for the signal to be returned to receiver.

The differences are measured as phase shift from which doppler frequency is measured. As velocity of blood increases, the doppler frequency increases. The first application of doppler in obstetrics was done by FITGERALD and DRUMM \(^{(43)}\). Shigeo Satomura from Japan developed first doppler for diagnostic purposes\(^{(44)}\).

PHYSICAL PRINCIPLES OF DOPPLER USG

Sound is a form of mechanical energy which travels through both liquid and solid media as pressure waves.

The propagation of sound in a medium is the rate of change of position of sound wave in unit time. The wavelength of sound comprises of one cycle of compression and refraction. It is the distance between pair of consecutive peaks or troughs of adjacent pressure waves.

The frequency of sound is the number of cycles in one second. One cycle=1 Hertz. Sound frequency ranges from 10HZ-20KHZ is audible. Sound with more than 20KHZ frequencies are inaudible to human ear and
are known as ultrasonic waves. In doppler USG frequency range of 2-10 MHz is employed. 2-5 MHz frequency range is used in obstetric transducer.

DOPPLER EQUIPMENTS

Three types

- Continuous wave doppler.
- Pulsed wave doppler.
- Colour flow mapping.

CONTINUOUS WAVE DOPPLER

It uses continuous transmission and reception of ultrasound. Continuous wave doppler is unable to determine specific location of velocities with the beam and cannot be used to produce color flow images. It uses 2 transducers.

PULSED WAVE DOPPLER

The transmitted beam power of pulsed doppler is higher than that of the safety standards for fetus studies recommended by National institute for Health. It uses one transducer which emits waves for short period and then acts as receiver for reflected waves.
COLOR FLOW DOPPLER

The color represents direction, magnitude and flow of the circulation. The color is based on hue, luminance, and saturation. The direction of flow in relation to transducer is in primary colors of blue (away from transducer), red (towards the transducer).

Normal Doppler Study
DOPPLER STUDY IN UTEROPLACENTAL INSUFFICIENCY

Doppler USG is used now-a-days for assessing uteroplacental insufficiency thereby preeclampsia and FGR is earlier predicted. It was first demonstrated by Campbell in 1983 (45). The feasibility of its fetal application was demonstrated by Fitzgerald and Drumm (46).

The uterine artery doppler is measured at a point just distal to the crossover with the iliac arteries before uterine artery divides into arcuate arteries.

Abnormal Doppler Study in utero placental insufficiency

Normal uterine artery doppler form

In non pregnant women, there is a steep systolic flow and an early diastolic notch showing high vascular resistance (47). At 4 weeks after implantation, well defined low resistant vessels are seen in future
placenta (48). In second trimester, uncoiling of uterine and spiral arteries occurs so that low resistance occurs (49). In later trimester, there is gradual removal of notch and increase in diastolic flow and decrease in resistance index. Resistance index was used as screening tool, but it has low sensitivity.

- Pai et al (50,51,52) found persistent diastolic notch as better screening tool than resistant index.
- Bollar et al demonstrated that presence of notch in the artery homolateral to placenta was associated with poor prognosis.
- Michael S.Kraner et al (53) mentioned environmental factors like stress, low socioeconomic status and overcrowded housing increase cortisol levels higher in maternal and fetal circulation and that leads to impaired placentation.

**INDICES USED IN DOPPLER**

- Arterial system
- S/D ratio = systolic peak velocity/end diastolic velocity.
- S-D/S = Resistance index.
- S-D/Mean frequency shift = pulsatility index.
MATERIALS AND METHODS

This study was conducted to find out the sensitivity of uterine artery doppler in predicting pregnancy induced hypertension and intrauterine growth restriction at 20-22 weeks of gestation, thereby to follow up the at risk patients and to improve perinatal outcome.

The study was conducted at Tirunelveli Medical College hospital from June 2013 to August 2014 in the department of Obstetrics and Gynaecology and in the department of Radiology.

SELECTION OF CASES

About 200 antenatal mothers were selected and they were separated as

i. High risk (Group I).

ii. Low risk (Group II).

* High risk cases include 100 antenatal mothers with previous history of hypertension, FGR, IUD at 20-22 weeks of gestation.

* Low risk cases include 100 antenatal mothers (primi / multipara) at 20-22 weeks with no prior history of hypertension, FGR, IUD.

INCLUSION CRITERIA

GROUP I

Antenatal mother (multipara) with previous history of Hypertension, FGR, intrauterine death.
GROUP II

Antenatal mother (primi/multi) with no history of hypertension, FGR, intrauterine death.

EXCLUSION CRITERIA

* Multiple gestations.

* Antenatal mother with cardiac diseases, DM, SLE, chronic hypertension and epilepsy.

METHOD OF STUDY

All antenatal mothers were registered in Antenatal OP. A detailed history elicited and then examination done. After getting consent, doppler study done at 20-22 weeks of gestation. The doppler characters studied for prediction of pre-eclampsia and FGR was bilateral diastolic notch.

DOPPLER STUDY METHOD

Antenatal mother is placed in a supine and slightly left lateral position to prevent supine hypotension. The frequency of doppler used is 3.5-5 MHZ. Doppler measurement is done at a point just distal to the crossover with the iliac artery before uterine artery divides into arcuate arteries.
RESULTS AND ANALYSIS

Computer statistical analysis was used to analyse the statistics. Comparison of data was done using chi-square test. Both univariate and multivariate analysis of data was done.

Validity of the tests was evaluated by calculating sensitivity, specificity, positive and negative predictive values, likelihood ratio for positive and negative test with 95% confidence interval. A likelihood ratio of 1 means the test has no predictive value. A likelihood ratio of >10 or <0.1 should be needed for a +ve and –ve test result respectively. A likelihood ratio of 1-5 and 0.2-1 means mild prediction. A likelihood ratio of 5-10 and 0.1-0.2 means moderate prediction. A likelihood ratio is independent of prevalence and it combines sensitivity and specificity. A likelihood ratio has a good predictive value.

In group, I, (High risk) 100 cases and in group II (low risk) 100 cases were selected and prospectively followed up. 3 cases in group I and 2 cases in group II were lost to follow up. The selected cases had uterine artery evaluation between 20-22 weeks gestation and followed up for development of hypertensive disorders, fetal growth restriction, gestational age at delivery, mode of delivery and perinatal outcome. Cases included were mainly belonging to class IV socioeconomic status.
1. AGE DISTRIBUTION OF CASES:-

Table - I

| Age       | No of Cases | Group – I | Group - II |
|-----------|-------------|-----------|------------|
| 18 - 20 Yrs | 12          | 25        |            |
|           | (12%)       | (50%)     |            |
| 21 - 30 Yrs | 71          | 72        |            |
|           | (71%)       | (72%)     |            |
| 31 - 35 Yrs | 17          | 3         |            |
|           | (17%)       | (3%)      |            |

In this study, 71 cases (71%) in group I and 72 cases (72%) in group II belonged to the age group of 21-30 yrs. 12 cases (12%) in group I and 25 cases (25%) in group II belonged to the age group of 18-20 yrs and the remaining belonged to the age group of 31-35 years.

AGE DISTRIBUTION
2. PARITY DISTRIBUTION CASES :-

**TABLE II**

**GROUP - I**

| Parity | Count | Percentage |
|--------|-------|------------|
| Multi  | 100   | 100%       |
| Primi  | 0     | 0%         |
| Total  | 100   | 100%       |

In Group I, all the 100 cases (100%) were multigravida.

**GROUP II**

| Parity | Count | %   |
|--------|-------|-----|
| Multi  | 40    | 40.00 |
| Primi  | 60    | 60.00 |
| Total  | 100   | 100  |

In Group II, 40 cases (40%) were multigravida, 60 cases (60%) were primigravida.
3. NOTCH DISTRIBUTION :-

**TABLE - IV**

**GROUP - I**

| Notch     | Count | %   |
|-----------|-------|-----|
| Absent    | 59    | 60.82 |
| Bilateral | 33    | 34.02 |
| Unilateral| 5     | 5.15 |
| Total     | 97    | 100 |

In Group I, bilateral notch was present in 33 cases (34.02%) and unilateral notch was present in 5 cases (5.15%).
In Group II, bilateral notch was present in 12 cases (12.24%) and unilateral notch was present in 6 cases (6.12%).
4. DISTRIBUTION OF CASES IN RELATION TO PARITY

TABLE - VI - A

GROUP - I

| Notch      | Primi | Multi | Total |
|------------|-------|-------|-------|
| **Bilateral** | 0 (0.00%) | 33 (100.00%) | 33 |
| **Unilateral** | 0 (0.00%) | 5 (100.00%) | 5 |

P = <0.001

In Group I, in cases with persistence of bilateral notch 33 (100.0%) cases were multi and no cases (0.00%) in primi. In cases with persistence of unilateral notch, 5 cases (100.0%) were multi and no cases (0.00%) were reported in primi. P value of <0.001 indicates significant (at 5%) relationship between notch & parity. Notch is associated with multigravida.
GROUP - I RELATION TO PARITY

GROUP - II RELATION TO PARITY
| Notch   | Parity |   |   |   |
|---------|--------|---|---|---|
|         | Primi  | Multi | Total |
|         | 8      | 4    | 12   |
|         | (66.7%)| (33.3%)|       |
| Bilateral |       |       |       |
| Unilateral | 4    | 2    | 6    |
|          | (66.7%)| (33.3%)|       |

P value=0.022

In Group II, persistence of bilateral notch were noted in 8 (66.7%) of cases in primi and in multi 4 cases (33.3%) were noted. Persistence of unilateral notch was noted in 4 cases (66.7%) in primi and 2 cases in multi (33.3%).

P-value of 0.022 indicates significant relationship between notch and parity. Notch is associated with parity.
5. NOTCH AND HTD/FGR:-

TABLE-VII-A

GROUP - I

| Notch   | Number | Normal outcome | HTD  | FGR  |
|---------|--------|----------------|------|------|
|         |        |                |      |      |
| Bilateral |       |                |      |      |
|         | 33     | 16             | 2    | 15   |
|         | (34.0%)| (48.4%)        | (6.1%)| (45.4%)|
| Unilateral |       |                |      |      |
|         | 5      | 1              | 1    | 3    |
|         | (5.1%) | (20.0%)        | (20.0%)| (60.0%)|
| Total   |        |                | 3    | 18   |
|         | 38     | 17             |      | (47.3%)|
|         | (39.2%)| (44.7%)        | (7.8%)|      |
| Absent  |        |                |      |      |
|         | 59     | 51             | 4    | 4    |
|         | (60.5%)| (86.4%)        | (6.7%)| (6.7%)|

* In group I, 2 cases (6.1%) had HTD and 15 cases (45.4%) had FGR in those cases with persistence of bilateral uterine artery notch.

* In group I, 1 case (20.0%) had HTD and 3 cases (60.0%) had FGR in the case with persistence of unilateral uterine artery notch.

* In group I, 4 cases (6.7%) had HTD, and 4 cases (6.7%) had FGR in the absence of notch.
### TABLE VIII- A

#### GROUP – II

| Notch   | Number | Normal outcome | HTD  | FGR   |
|---------|--------|----------------|------|-------|
| Bilateral | 12     | 7 (58.3%)      | 1 (8.3%) | 2 (16.7%) |
| Unilatera | 6      | 5 (83.3%)      | 0 (0.0%) | 1 (8.3%)  |
| Total    | 18     | 12 (66.7%)     | 1 (5.5%)  | 3 (16.7%) |
| Absent   | 80     | 79 (98.7%)     | 0 (0.0%)  | 0 (0.0%)  |

In group II, 1 case (8.3%) had HTD, 2 cases (16.7%) had FGR in the cases of persistence of bilateral uterine artery notch.

In group II, no cases were reported to have hypertension in both unilateral and absent notches. 1 case (8.3 %) had FGR in the cases of persistence of unilateral uterine artery notch and no case had FGR in cases of absent notch.
### TABLE - VIII- B

| Notch    | Number | FGR with HTD | FGR without HTD | HTD without |
|----------|--------|--------------|-----------------|-------------|
|          |        |              |                 |             |
| Bilateral| 12     | 2 (16.7%)    | 3 (25.0%)       | 1 (8.3%)    |
|          | (12.2%)|              |                 |             |
| Unilateral| 6     | 1 (16.7%)    | 1 (16.7%)       | 0 (0.0%)    |
|          | (6.1%) |              |                 |             |
| Total    | 18     | 3 (16.7%)    | 4 (22.2%)       | 1 (5.5%)    |
|          | (18.4%)|              |                 |             |
| Absent   | 80     | 0 (0.0%)     | 2 (2.5%)        | 2 (2.5%)    |
|          | (81.6%)|              |                 |             |

In group II, 2 cases (16.7%) had HTD with FGR in cases with persistence of bilateral uterine artery notch.

In group II, 1 case (16.7%) had HTD with FGR in the presence of unilateral uterine artery notch.
Group I - NOTCH VS HTD / FGR

- Bilateral: 45.60%
- Unilateral: 20.00%
- Absent: 5.10%

Group II - NOTCH VS HTD / FGR

- Bilateral: 16.70%
- Unilateral: 16.70%
- Absent: 2.50%
### Table - IX-A

**OVER ALL RESULTS:**

| Notch     | Number | Normal outcome | HTD | FGR     |
|-----------|--------|----------------|-----|---------|
| **Bilateral** | 45     | 23             | 3   | 17      |
|            | (23.1%)| (51.1%)        | (6.7%)| (37.8%) |
| **Unilateral** | 11     | 6              | 1   | 4       |
|            | (5.6%) | (54.5%)        | (9.1%)| (36.4%) |
| **Total**  | 56     | 29             | 4   | 21      |
|            | (28.7%)| (51.8%)        | (7.1%)| (37.5%) |
| **Absent** | 139    | 130            | 4   | 4       |
|            | (71.3%)| (93.5%)        | (2.9%)| (2.9%)  |

**Over all Results**

| Bilateral | Unilateral | Absent |
|-----------|------------|--------|
| 51.10%    | 54.50%     | 93.50% |
| 37.80%    | 36.40%     | 2.90%  |
| 9.10%     | 2.90%      | 0.00%  |

- **Normal outcome**
- **HTD**
- **FGR**
### Table - IX-B

| Notch    | Number | FGR with HTD | FGR without HTD | HTD without FGR | FGR without HTD |
|----------|--------|--------------|-----------------|-----------------|-----------------|
| **Bilateral** | 45     | 18 (40.0%)   | 9 (20.0%)       | 3 (6.7%)        |                 |
|          | (23.1%)|              |                 |                 |                 |
| **Unilateral** | 11     | 4 (36.4%)   | 2 (18.2%)       | 1 (9.1%)        |                 |
|          | (5.6%) |              |                 |                 |                 |
| **Total** | 56     | 22 (39.3%)   | 11 (19.6%)      | 4 (7.1%)        |                 |
|          | (28.7%)|              |                 |                 |                 |
| **Absent** | 139    | 3 (2.2%)    | 3 (2.2%)        | 6 (4.3%)        |                 |
|          | (71.3%)|              |                 |                 |                 |

In both groups (195 cases), notch was seen in 56 cases (28.7%). Among them 4 cases had HTD (7.1), 21 cases (37.5%) had FGR, 22 cases had FGR with HTD (39.3%).
6. NOTCH AND HTD:-

GROUP - I

TABLE X-A

|    | NOTCH       | HTD       | Total |
|----|-------------|-----------|-------|
|    | Absent      | Present   |       |
| Absent | 55         | 4         | 59    |
| Bilateral | 31         | 2         | 33    |
| Unilateral | 4          | 1         | 5     |
| Total   | 90         | 7         | 97    |

P= 0.835

**Conclusion:** P- value of 0.835 indicates insignificant relationship between notch and hypertensive disorder.

**Group I- Notch and HTD**
### Table - X-B

| NOTCH     | HTD        | Total |
|-----------|------------|-------|
|           | Absent | Present |       |
| Absent    | 78     | 2       | 80    |
| Bilateral | 11     | 1       | 12    |
| Unilateral| 6      | 0       | 6     |
| Total     | 95     | 3       | 98    |

P = 0.923

**Conclusion:** P-value of 0.923 indicates insignificant relationship between notch and hypertensive disorder.

### Group II-Notch and HTD

![Graph showing notch and HTD distribution](image-url)
7. NOTCH AND FGR:-

GROUP - I

TABLE XI-A

| NOTCH       | FGR         | Total |
|-------------|-------------|-------|
|             | Present     | Absent|       |
| Absent      | 4           | 55    | 59    |
| Bilateral   | 15          | 18    | 33    |
| Unilateral  | 3           | 2     | 5     |
| Total       | 22          | 75    | 97    |

P = <0.001

**Conclusion:** P- value of < 0.000 indicates significant relationship between notch and FGR.
TABLE - XI-B

GROUP II

| NOTCH     | FGR       | Total |
|-----------|-----------|-------|
|           | Present   | Absent|       |
| Absent    | 2         | 78    | 80    |
| Bilateral | 3         | 9     | 12    |
| Unilateral| 0         | 6     | 6     |
| Total     | 5         | 93    | 98    |

P = 0.092

Conclusion:- P - value of 0.092 indicates insignificant relationship between notch and FGR.
8. NOTCH AND HTD-FGR:-

**TABLE - XII-A**

**GROUP I**

| NOTCH      | HTD-FGR |     |     |
|------------|---------|-----|-----|
|            | Absent  | Present | Total |
| Absent     | 58      | 1    | 59   |
| Bilateral  | 27      | 6    | 33   |
| Unilateral | 4       | 1    | 5    |
| **Total**  | **89**  | **8** | **97** |

P=0.022

**Conclusion:** P value of 0.022 indicates significant relationship between notch and HTD-FGR.
### TABLE XIB

| NOTCH     | HTD-FGR |       |       |       |
|-----------|---------|-------|-------|-------|
|           | Absent  | Present| Total |       |
| Absent    | 80      | 0     | 80    |       |
| Bilateral | 10      | 2     | 12    |       |
| Unilateral| 5       | 1     | 6     |       |
| Total     | 95      | 3     | 98    |       |

**P = 0.007**

**Conclusion**: P-value of 0.007 indicates significant relationship between bilateral notch and HTD-FGR.

**GROUP - II  NOTCH AND HTD - FGR**

![Graph showing the distribution of HTD-FGR Absent and Present across Absent, Bilateral, and Unilateral categories.](image)
In this study, in Group I i.e the cases with persistence of bilateral notch in 2 (6.1%) had gestational HT, 6 (18.2%) had mild preeclampsia and 10 (30.3%) had severe preeclampsia.

In the cases with persistence of unilateral notch 1 (20.2%) had gestational HT, 1 (20.0%) had mild preeclampsia and 1 case (20.0%) had severe preeclampsia.
In this study, in Group II i.e the cases of persistence of bilateral notch 1 (8.3%) had gestational HT, 1 (8.3%) had mild preeclampsia and 1(8.3%) had severe preeclampsia.

In the cases of unilateral notch 1 case (16.7%) had mild preeclampsia.
GROUP - I  PERSISTENCE OF NOTCH AND HTD

|                | Bilateral | Unilateral | Absent notch |
|----------------|-----------|------------|--------------|
| Gest HT        | 20        | 6.1        | 6.8          |
| Mild           | 18.2      | 20         | 0            |
| Severe         | 30.3      | 20         | 1.7          |

GROUP - II  PERSISTENCE OF NOTCH AND HTD

|                | Bilateral | Unilateral | Absent notch |
|----------------|-----------|------------|--------------|
| Gest HT        | 8.3       | 0          | 2.5          |
| Mild           | 8.3       | 16.7       | 0            |
| Severe         | 8.3       | 0          | 0            |
10. MODE OF DELIVERY AND PERSISTENCE OF NOTCH:-

Group - I

Table –XIV - A

| Notch   | No of cases | Mode of delivery |   |   |
|---------|-------------|------------------|---|---|
|         |             | Vaginal          | Caesarean |
| Bilateral | 33          | 19 (57.6%)       | 14 (42.4%) |
| Unilateral | 5           | 3 (60.0%)        | 2 (40.0%)  |
| Total     | 38          | 22 (59.9%)       | 16 (42.1%) |
| Absent    | 59          | 49 (83.1%)       | 10 (16.9%) |

In Group I, in the presence of bilateral notch, 19 cases (57.6%) had vaginal delivery and 14 cases (42.4%) had caesarean delivery.

In the presence of unilateral notch, 3 cases (60.0%) had vaginal delivery and 2 cases (40.0%) had caesarean delivery.
In Group II, 7 cases (58.3%) had vaginal delivery and 5 cases (41.7%) had cesarean delivery in cases of bilateral notch, 5 cases (83.3%) had vaginal and 1 case (16.7%) had cesarean delivery with unilateral notch.
GROUP - 1
MODE OF DELIVERY VS PERSISTENCE OF NOTCH

GROUP - II
MODE OF DELIVERY VS PERSISTENCE OF NOTCH
11. PERSISTENCE OF NOTCH AND GESTATIONAL AGE AT DELIVERY:-

Group - I

Table – XV – A

| Notch       | No of cases | Gestational Age At Delivery |
|-------------|-------------|----------------------------|
|             |             | <37 weeks | >37 weeks |
| Bilateral   | 33          | 10 (30.3%) | 23 (69.7%) |
| Unilateral  | 5           | 1 (20.0%) | 4 (80.0%)  |
| Total       | 38          | 11 (28.9%) | 27 (71.0%) |
| Absent notch | 59         | 5 (8.47%) | 54 (91.5%) |

In Group I, in the presence of bilateral notch, 10 cases (30.3%) had delivery at less than 37 weeks of gestation and in the presence of unilateral notch, 1 case (20.0%) had delivery at less than 37 weeks of gestation.
GROUP - 1
PERSISTENCE OF NOTCH AND GESTATIONAL AGE AT DELIVERY

| GROUP | <37 weeks | >37 weeks |
|-------|-----------|-----------|
| I     | 54        | 4         |
| II    | 23        | 10        |
| III   | 10        | 4         |
| IV    | 0         | 2         |
| V     | 2         | 2         |

COMPARISON OF GESTATIONAL AGE IN WEEKS AND NOTCH
In Group II, in the presence of bilateral notch, 2 cases (16.7%) had delivery at less than 37 weeks of gestation and in the presence of unilateral notch 2 cases (33.3%) had delivery at less than 37 weeks of gestation.
In Group I, in the presence of bilateral notch, 17 cases (51.5%) had abnormal perinatal outcome and in the presence of unilateral notch 4 cases (80.0%) had abnormal perinatal outcome.

Abnormal perinatal outcome was noted as apgar <6/10, meconium aspiration syndrome, respiratory distress, small for gestational age, preterm delivery and its complications and NICU admission.
In Group II, in the presence of bilateral notch, 5 cases (41.7%) had abnormal perinatal outcome and in the presence of unilateral notch 1 case (16.7%) had abnormal perinatal outcome.
COMPARISON OF NOTCH VS OUTCOME IN GROUP-I AND GROUP-II

| GROUP I | GROUP II |
|---------|---------|
| Abnormal | Normal  |
| 8       | 17      |
| 16      | 1       |
| 4       | 1       |
| 1       | 5       |
| 1       | 1       |
| 7       | 7       |
| 5       | 5       |

Legend:
- Absent
- Bilateral
- Unilateral
13. NOTCH AND MODE OF DELIVERY:-

Group I

Table –XVII - A

| Notch       | Mode of delivery | Total |
|-------------|------------------|-------|
|             | Caesarean | Vaginal |     |
| Absent      | 10       | 49      | 59  |
| Bilateral   | 14       | 19      | 33  |
| Unilateral  | 2        | 3       | 5   |
| Total       | 26       | 71      | 97  |

P = 0.069

**Conclusion:** P-value of 0.069 indicates insignificant relationship between notch and mode of delivery.
### Group II

**Table – XVII - B**

| NOTCH      | Mode of Delivery | Total |
|------------|------------------|-------|
|            | Caesarean | Vaginal |       |
| Absent     | 12        | 68      | 80    |
| Bilateral  | 5         | 7       | 12    |
| Unilateral | 1         | 5       | 6     |
| Total      | 26        | 80      | 98    |

P = 0.261

**Conclusion**: P-value of 0.261 indicates insignificant relationship between notch and mode of delivery.
**GROUP I**  
PERSISTENCE OF NOTCH AND GESTATIONAL AGE AT DELIVERY

- **<37 weeks**
  - Bilateral: 16.7%
  - Unilateral: 33.3%
  - Absent notch: 0%

- **>37 weeks**
  - Bilateral: 83.3%
  - Unilateral: 66.7%
  - Absent notch: 100%

**GROUP II**

- **Caesarean**
  - Absent: 10
  - Bilateral: 14
  - Unilateral: 2

- **Vaginal**
  - Absent: 49
  - Bilateral: 19
  - Unilateral: 3

- **Caesarean**
  - Absent: 12
  - Bilateral: 5
  - Unilateral: 1

- **Vaginal**
  - Absent: 68
  - Bilateral: 7
  - Unilateral: 5
14. NOTCH AND GESTATIONAL AGE AT DELIVERY:-

Group I

Table – XVIII - A

| Notch   | Gestational age | Total |
|---------|-----------------|-------|
|         | >37wks          | <37 wks |     |
| Absent  | 54              | 4      | 58   |
| Bilateral | 23             | 10     | 33   |
| Unilateral | 4              | 1      | 5    |
| Total   | 81              | 15     | 96   |

P = 0.482

Conclusion: P-value of 0.482 indicates an insignificant relationship between notch and gestational age at delivery.
Table XVIII-B

Group II

| Notch   | Gestational age | Total |
|---------|-----------------|-------|
|         | >37 wks         | <37 wks |     |
| Absent  | 80              | 0      | 80   |
| Bilateral | 10            | 2      | 12   |
| Unilateral | 4              | 2      | 6    |
| Total   | 94              | 4      | 98   |

P = 0.651

Conclusion

P-value of 0.651 (only at 5%) indicates an insignificant relationship between notch and gestational age at delivery.
15. NOTCH AND PERINATAL OUTCOME:-

Group I

Table –XIX - A

| Notch    | Perinatal outcome | Total |
|----------|-------------------|-------|
|          | Abnormal | Normal |       |
| Absent   | 8        | 51     | 59    |
| Bilateral| 17       | 16     | 33    |
| Unilateral| 4      | 1      | 5     |
| Total    | 29       | 68     | 97    |

P=0.003

**Conclusion:** P-value of 0.003 (only at 5%) indicates a significant relationship between notch and perinatal outcome. Abnormal Perinatal outcome is associated with Unilateral and Bilateral Notch.
Group II

Table –XIX - B

| Notch   | Perinatal Outcome | Total |
|---------|------------------|-------|
|         | Abnormal | Normal |       |
| Absent  | 1        | 79     | 80    |
| Bilateral | 5        | 7      | 12    |
| Unilateral | 1        | 5      | 6     |
| Total   | 7        | 91     | 98    |

P=<0.001

**Conclusion**: P-value of < 0.001 indicates significant (at 5%) relationship notch and perinatal outcome. Notch is associated with perinatal abnormality.
GROUP - I PERSISTENCE OF NOTCH AND PERINATAL OUTCOME

GROUP - II PERSISTENCE OF NOTCH AND PERINATAL OUTCOME
Doppler Study

| Notch | Out |  |
|-------|-----|---|
|       |  +  |  - |
| +     | TP$^a$ | FN$^c$ |
| −     | FP$^b$ | TN$^d$ |

Following measures are used to evaluate a screening test:

1) Sensitivity = \[ \frac{a}{a + c} \times 100 \]
2) Specificity = \[ \frac{d}{b + d} \times 100 \]
3) Positive predictive value of the test = \[ \frac{a}{a + b} \times 100 \]
4) Negative predictive value of the test = \[ \frac{d}{c + d} \times 100 \]
5) Likelihood ratio (+) test = \[ \frac{\text{Sensitivity}}{1 - \text{Specificity}} \]
6) Likelihood ratio (−) test = \[ \frac{1 - \text{Sensitivity}}{\text{Specificity}} \]
7) Percentage of false positive = \[ \frac{b}{b + d} \times 100 \]
8) Percentage of false negative = \[ \frac{c}{a + c} \times 100 \]
Group - I

1. Any Notch for HTD

| Notch | HTD + | HTD – |
|-------|------|------|
| +     | 3    | 4    | 7    |
| –     | 35   | 55   | 90   |
|       | 38   | 59   | 97   |

1) Sensitivity
   \[ \text{Sensitivity} = \frac{3}{7} \times 100 = 42.85\% \]

2) Specificity
   \[ \text{Specificity} = \frac{55}{90} \times 100 = 61.11\% \]

3) Positive predictive value of the test
   \[ \text{Positive predictive value} = \frac{3}{38} \times 100 = 7.89\% \]

4) Negative predictive value of the test
   \[ \text{Negative predictive value} = \frac{55}{59} \times 100 = 93.22\% \]

5) Likelihood ratio (+) test
   \[ \text{Likelihood ratio (+)} = \frac{0.43}{1 - 0.61} = 1.10\% \]

6) Likelihood ratio (–) test
   \[ \text{Likelihood ratio (–)} = \frac{1 - 0.43}{0.60} = 0.93\% \]
2. Bilateral Notch for Hypertension

|            | +  | −  |
|------------|----|----|
| **HTD**    |    |    |
| +          | 2  | 4  |
| −          | 31 | 60 |
|            | 33 | 64 |

|                              |               |
|------------------------------|---------------|
| **Bilateral Notch**          |               |
|                              | +  | −  |    |
| **HTD**                      | 2  | 4  | 6  |
|                              | 31 | 60 | 91 |
|                              | 33 | 64 | 97 |

1) Sensitivity = \( \frac{2}{6} \times 100 = 33.3\% \)

2) Specificity = \( \frac{60}{91} \times 100 = 65.93\% \)

3) Positive predictive value of the test = \( \frac{2}{33} \times 100 = 6.1\% \)

4) Negative predictive value of the test = \( \frac{60}{64} \times 100 = 93.75\% \)

5) Likelihood ratio (+) test = \( \frac{0.33}{1 - 0.66} = 0.97 \)

6) Likelihood ratio (−) test = \( \frac{1 - 0.33}{0.66} = 1.01 \)
3. Any Notch for FGR

| Any Notch | + | − |
|-----------|---|---|
| **FGR**   |   |   |
| +         | 18| 4 | 22|
| −         | 20| 55| 75|
|           | 38| 59| 97|

1) Sensitivity
\[\text{Sensitivity} = \frac{18}{22} \times 100 = 81.81\%\]

2) Specificity
\[\text{Specificity} = \frac{55}{75} \times 100 = 73.33\%\]

3) Positive predictive value of the test
\[\text{Positive predictive value} = \frac{18}{38} \times 100 = 47.37\%\]

4) Negative predictive value of the test
\[\text{Negative predictive value} = \frac{55}{59} \times 100 = 93.22\%\]

5) Likelihood ratio (+) test
\[\text{Likelihood ratio (+)} = \frac{0.82}{1 - 0.73} = 3.04\]

6) Likelihood ratio (−) test
\[\text{Likelihood ratio (−)} = \frac{1 - 0.82}{0.73} = 0.25\]
4. Bilateral Notch for FGR

|          | +  | –  |
|----------|----|----|
| **FGR**  |    |    |
| +        | 15 |  4 |
| –        | 18 | 60 |
|          | 33 | 64 |

1) Sensitivity
\[
\text{Sensitivity} = \frac{15}{19} \times 100 = 78.95\%
\]

2) Specificity
\[
\text{Specificity} = \frac{60}{78} \times 100 = 76.92\%
\]

3) Positive predictive value of the test
\[
\text{Positive predictive value of the test} = \frac{15}{33} \times 100 = 45.45\%
\]

4) Negative predictive value of the test
\[
\text{Negative predictive value of the test} = \frac{60}{64} \times 100 = 93.74\%
\]

5) Likelihood ratio (+) test
\[
\text{Likelihood ratio (+) test} = \frac{0.79}{1 - 0.77} = 2.39
\]

6) Likelihood ratio (–) test
\[
\text{Likelihood ratio (–) test} = \frac{1 - 0.79}{0.77} = 0.27
\]
Group II

1. Any Notch for HTD

| HTD  | +  | −  |
|------|----|----|
| +    | 1  | 2  | 3  |
| −    | 17 | 78 | 95 |
|      | 18 | 80 | 98 |

Any Notch

1) Sensitivity $= \frac{1}{3} \times 100 = 33.3\%$

2) Specificity $= \frac{78}{95} \times 100 = 82.10\%$

3) Positive predictive value of the test $= \frac{1}{18} \times 100 = 5.56\%$

4) Negative predictive value of the test $= \frac{78}{80} \times 100 = 97.5\%$

5) Likelihood ratio (+) test $= \frac{0.33}{1 - 0.91} = 3.66$

6) Likelihood ratio (−) test $= \frac{1 - 0.33}{0.91} = 0.73$
2. Bilateral Notch for Hypertension

| HTD | +  | –  |
|-----|----|----|
| +   | 1  | 2  | 3  |
| –   | 11 | 84 | 95 |
|     | 12 | 86 | 98 |

1) Sensitivity
\[ \text{Sensitivity} = \frac{1}{3} \times 100 = 33.33\% \]

2) Specificity
\[ \text{Specificity} = \frac{84}{94} \times 100 = 88\% \]

3) Positive predictive value of the test
\[ \text{Positive predictive value of the test} = \frac{1}{12} \times 100 = 8.33\% \]

4) Negative predictive value of the test
\[ \text{Negative predictive value of the test} = \frac{84}{86} \times 100 = 97.6\% \]

5) Likelihood ratio (+) test
\[ \text{Likelihood ratio (+) test} = \frac{0.33}{1 - 0.88} = 2.75 \]

6) Likelihood ratio (–) test
\[ \text{Likelihood ratio (–) test} = \frac{1 - 0.33}{0.88} = 0.76 \]
3. Any Notch for FGR

| Any Notch | + | − |
|-----------|---|---|
| FGR       |   |   |
| +         | 3 | 2 | 5 |
| −         | 15| 78| 93|
|           | 18| 80| 98|

1) Sensitivity
   \[ \text{Sensitivity} = \frac{3}{5} \times 100 = 60\% \]

2) Specificity
   \[ \text{Specificity} = \frac{78}{93} \times 100 = 83.8\% \]

3) Positive predictive value of the test
   \[ \text{PPV} = \frac{3}{18} \times 100 = 16.67\% \]

4) Negative predictive value of the test
   \[ \text{NPV} = \frac{78}{80} \times 100 = 97.2\% \]

5) Likelihood ratio (+) test
   \[ \text{LR+} = \frac{0.60}{1 - 0.83} = 3.52 \]

6) Likelihood ratio (−) test
   \[ \text{LR−} = \frac{1 - 0.60}{0.83} = 1.5 \]
3. Bilateral Notch for FGR

|   | +   | –   |
|---|-----|-----|
| + | 3   | 2   |
| – | 9   | 84  |
|   | 12  | 86  | 98  |

**Bilateral Notch**

1) Sensitivity
   \[
   \frac{3}{5} \times 100 = 60\%
   \]

2) Specificity
   \[
   \frac{84}{93} \times 100 = 90.32\%
   \]

3) Positive predictive value of the test
   \[
   \frac{3}{12} \times 100 = 25\%
   \]

4) Negative predictive value of the test
   \[
   \frac{84}{86} \times 100 = 97\%
   \]

5) Likelihood ratio (+) test
   \[
   \frac{0.6}{1 - 0.9} = 6
   \]

6) Likelihood ratio (–) test
   \[
   \frac{1 - 0.6}{0.9} = 0.4
   \]
**PREDICTION OF HTD /FGR BY UTERINE ARTERY DOPPLER SCREENING**

For Group - I

| Diagnostic Test | Sensitivity | Specificity | PPV  | NPV  | LR for + test (95% CI) | LR for (-) Test (95% CI) | FP   | FN   |
|-----------------|-------------|-------------|------|------|------------------------|--------------------------|------|------|
| **For HTD**     |             |             |      |      |                        |                          |      |      |
| Any notch       | 42.85%      | 61.11%      | 7.89%| 93.22%| 1.10                   | 0.93                     | 57.14%| 92.10%|
| Bilateral notch | 33.33%      | 65.93%      | 6.1% | 93.75%| 0.97                   | 1.01                     | 66.67%| 93.94%|
| **For FGR**     |             |             |      |      |                        |                          |      |      |
| Any notch       | 81.81%      | 73.33%      | 47.37%| 93.22%| 3.04                   | 0.25                     | 18.18%| 52.63%|
| Bilateral notch | 78.95%      | 76.92%      | 45.45%| 93.75%| 2.39                   | 0.27                     | 21.05%| 54.55%|
### For Group – II

| Diagnostic Test | Sensitivity | Specificity | PPV  | NPV   | LR for + test (95% CI) | LR for (-) Test (95% CI) | FP       | FN       |
|-----------------|-------------|-------------|------|-------|------------------------|--------------------------|---------|---------|
|                 |             |             |      |       |                        |                         |         |         |
| **For HTD**     |             |             |      |       |                        |                         |         |         |
| Any notch       | 33%         | 91%         | 5.5% | 97.5% | 3.66                   | 0.73                     | 17.8%  | 66.6%   |
| Bilateral notch | 33.3%       | 88%         | 8.3% | 97.6% | 2.74                   | 0.76                     | 11.57% | 66.6%   |
| **For FGR**     |             |             |      |       |                        |                         |         |         |
| Any notch       | 60%         | 83.8%       | 15%  | 97.5% | 3.5                    | 1.5                      | 16.12% | 40%     |
| Bilateral notch | 60%         | 90.32%      | 25%  | 97%   | 6                      | 0.4                      | 9.6%   | 40%     |
DISCUSSION

Doppler study application was made feasible first by Fitzgerald and Drumm. It is a noninvasive technique which uses high frequency sound waves for investigation of blood flow.

- In group I, 2 cases (6.1%) had HTD, 15 cases (45.4%) had FGR in cases with persistence of bilateral notch.

- In Group I, 1 case (20.0%) had HTD, 3 cases (60.0%) had FGR in the case with persistence of unilateral notch.

- In Group I, 4 cases (6.7%) had HTD, and 4 cases (6.7%) had FGR in case of absent notch.

- In Group II, 1 case (8.3%) had HTD, 2 cases (16.7%) had FGR in presence of bilateral notch.

- In Group II, no cases reported to have HT in both unilateral and absent notches.

- 1 case (8.3%) had FGR in case of persistence of unilateral notch and no case had FGR in case of absent notch.
Bilateral notch persistence was associated with severe form of HTD and FGR compared to unilateral notch.

Rofinas et al (54) found persistence of diastolic notch in uterine artery with increased risk of HTD, FGR, caesarean delivery, preterm delivery and admission to NICU.

Campbell et al (55) first demonstrated relationship between HTD, FGR, fetal distress, increased cesarean delivery and low APGAR score with persistent bilateral diastolic notch.

Deutinger et al (56) found that early diastolic notch was associated with increased uteroplacental insufficiency.

Zimmermann et al (57) studied the utility of uterine artery doppler between 21-24 weeks in prediction of preeclampsia and FGR. Doppler was less informative in cases of low risk. In case of bilateral notch, there is increased risk of preeclampsia and FGR. In case of bilateral notch, preeclampsia and FGR was noted in 58.3% compared to 8.3% in absent notch.

Pai (58) found that in predicting HTD/FGR, persistent diastolic notch was a better parameter than Resistant index.

Flesicher et al conducted the study after 26 weeks and found that early diastolic notch was associated with increased cesarean rate, preeclampsia, FGR, fetal distress and admission to NICU.
Thaler et al (59) found diastolic notch as a better outcome than S/D ratio and Resistance index (RI).

Bower et al also found correlation between diastolic notch and HTD, FGR, fetal distress.

Trudinger et al (60) studied only high risk patients for prediction of preeclampsia, FGR.

In this study, in Group I, in case of bilateral notch, 6.1% had gestational HT, 18.2% had mild preeclampsia, 30.3% had severe preeclampsia.

In case of unilateral notch, 20.0% had gestational HT, 20.0% had mild preeclampsia, 20.0% had severe preeclampsia.

In Group II, in cases of persistence of bilateral notch, 8.3% had gestational HT, 8.3% had mild preeclampsia, 8.3% had severe preeclampsia.

In case of unilateral notch, 16.7% had mild preeclampsia.

In Group I, in presence of bilateral notch, 42.4% had cesarean delivery, in case of unilateral notch, 40.0% had cesarean delivery.

In Group II, in presence of bilateral notch, 41.7% had cesarean delivery compared to 16.7% in case of unilateral notch.

Overall, increased risk of cesarean delivery is noted in Group I (High risk) cases and that to in cases with persistent bilateral notches.
Aristidou et al (61) and Christopher Lees (62) demonstrated persistent diastolic notches with increased risk of HT, FGR, and low APGAR scores.

In this study, preterm delivery was more common in High risk (Group I) cases.

In Group I, 30.3% had preterm delivery in case of bilateral notches, and only 20.0% had preterm delivery in case of unilateral notches.

The useful part of a test depends on negative predictive value. Negative predictive value of 100% in Group II (low risk) indicates that both HT/FGR will not be present.

Validity of tests in Group I&II for any notch and bilateral notch for hypertensive disorder/ fetal growth restriction when compared to other studies were,
For prediction of PIH

| Author              | Sensitivity | Specificity | Positive predictive value | Negative predictive value |
|---------------------|-------------|-------------|---------------------------|---------------------------|
| Agarwal             | 84          | 71.4        | 72                        | -                         |
| Papageorghiou et    | 41%         | -           | -                         | -                         |
| Bower et al         | 78          | 96          | 28                        | 99.5                      |
| May Backos et al    | 38          | 85          | 27                        | 90                        |
| Campbell et al      | 68%         | 69%         | -                         | -                         |
| Pai                 | 45.45       | 92          | 38                        | 93.87                     |

In this study, Group I

| Diagnostic Test | Sensitivity | Specificity | PPV | NPV | LR for + test (95% CI) | LR for (-) Test (95% CI) | FP | FN |
|-----------------|-------------|-------------|-----|-----|------------------------|--------------------------|----|----|
| Any notch       | 42.85%      | 61.11%      | 7.89% | 93.22% | 1.10                   | 0.93                     | 57.14% | 92.10% |
| Bilateral notch | 33.33%      | 65.93%      | 6.1% | 93.75% | 0.97                   | 1.01                     | 66.67% | 93.94% |
**Group II**

| Diagnostic Test | Sensitivity | Specificity | PPV | NPV | LR for + test (95% CI) | LR for (-) Test (95% CI) | FP | FN |
|-----------------|-------------|-------------|-----|-----|------------------------|--------------------------|----|----|
| For HTD         |             |             |     |     |                        |                          |    |    |
| Any notch       | 33%         | 91%         | 5.5%| 97.5%| 3.66                   | 0.73                     | 17.8%| 66.6%|
| Bilateral notch | 33.3%       | 88%         | 8.3%| 97.6%| 2.74                   | 0.76                     | 11.57%| 66.6%|
For prediction of FGR

| Author               | Sensitivity | Specificity | Positive predictive value | Negative predictive value |
|----------------------|-------------|-------------|---------------------------|---------------------------|
| May Backos et al     | 41%         | 85%         | 30%                       | 90%                       |
| Papageorghiou et al | 24%         | -           | -                         | -                         |

In this study, Group I

| Diagnostic Test       | Sensitivity | Specificity | PPV  | NPV  | LR for + test (95% CI) | LR for (-) Test (95% CI) | FP     | FN     |
|-----------------------|-------------|-------------|------|------|------------------------|--------------------------|--------|--------|
| **For FGR**           |             |             |      |      |                        |                          |        |        |
| **Any notch**         | 81.81%      | 73.33%      | 47.37%| 93.22%| 3.04                   | 0.25                     | 18.18% | 52.63% |
| **Bilateral notch**   | 78.95%      | 76.92%      | 45.45%| 93.75%| 2.39                   | 0.27                     | 21.05% | 54.55% |
In this study, Group II

| Diagnostic Test | Sensitivity | Specificity | PPV  | NPV  | LR for + test (95% CI) | LR for (-) Test (95% CI) | FP   | FN   |
|-----------------|-------------|-------------|------|------|------------------------|--------------------------|------|------|
| For FGR         |             |             |      |      |                        |                          |      |      |
| Any notch       | 60%         | 83.8%       | 15%  | 97.5%| 3.5                    | 1.5                      | 16.12%| 40%  |
| Bilateral notch | 60%         | 90.32%      | 25%  | 97%  | 6                      | 0.4                      | 9.6% | 40%  |

| Ashraf Jamal et al | Sensitivity | Specificity | Positive Predictive Value | Negative Predictive Value |
|--------------------|-------------|-------------|---------------------------|--------------------------|
| Preeclampsia       | 30.4        | 90.5        | 15.2                      | 95.9                     |
| FGR                | 47.1        | 90.9        | 17.4                      | 97.7                     |

| Author               | Sensitivity | Preeclampsia | FGR |
|----------------------|-------------|--------------|-----|
| Albaiges et al       | 35%         | 21%          |     |
| Harrington et al     | 55%         | 22%          |     |
| Bowley et al 1991    | -           | 10%          |     |
| Steel et al 1990     | -           | 33%          |     |
| Prajapati Saloni. R. Nandita et al | Sensitivity | Specificity | Positive Predictive Value | Negative Predictive Value | LR + Test | LR - Test |
|-----------------------------------|-------------|-------------|---------------------------|---------------------------|-----------|-----------|
| Preeclampsia                      | 30          | 94          | 50                        | 87.22                     | 5.06      | 0.74      |
SUMMARY

IN GROUP-I (HIGH RISK)

- 71% of cases belonged to 21-30 yrs, 12% of cases belonged to 18-20 yrs, 17% belonged to 31-35 yrs.
- All the 100 cases were multigravida.
- Bilateral notch was present in 34.02% of cases, Unilateral notch was present in 5.15% of cases.
- 6.1% had HTD, 45.4% had FGR, 18.2% had HTD with FGR, 42.4% had cesarean delivery, 30.3% had preterm delivery and 51.5% had abnormal perinatal outcome in cases of persistent diastolic notch.
- 20.0% had HTD, 60.0% had FGR, 1.7% had HT with FGR, 40% had cesarean delivery, 20.0% had preterm delivery and 80.0% had abnormal outcome in cases of unilateral notch.
- 6.7% had HTD, 6.7% had FGR, 1.7% had both HT and FGR, 16.9% had cesarean delivery, 8.47% had preterm delivery and 13.6% had abnormal outcome with absent notches.
- In Group I, there is a significant association between notch and parity, FGR, both HT/FGR, abnormal perinatal outcome, and insignificant association between notch and HT, mode of delivery, gestational age at delivery. In the presence of notch there is increased risk of FGR, both HT/FGR and abnormal perinatal outcome.
## FOR GROUP I

| Diagnostic Test | Sensitivity | Specificity | PPV | NPV | LR for + test (95% CI) | LR for - test (95% CI) | FP | FN |
|-----------------|-------------|-------------|-----|-----|-----------------------|------------------------|-----|-----|
| **For HTD**     |             |             |     |     |                       |                        |     |     |
| Any notch       | 42.85%      | 61.11%      | 7.89% | 93.22% | 1.10                  | 0.93                   | 57.14% | 92.10% |
| Bilateral notch | 33.33%      | 65.93%      | 6.1% | 93.75% | 0.97                  | 1.01                   | 66.67% | 93.94% |
| **For FGR**     |             |             |     |     |                       |                        |     |     |
| Any notch       | 81.81%      | 73.33%      | 47.37% | 93.22% | 3.04                  | 0.25                   | 18.18% | 52.63% |
| Bilateral notch | 78.95%      | 76.92%      | 45.45% | 93.75% | 2.39                  | 0.27                   | 21.05% | 54.55% |

## FOR GROUP II

| Diagnostic Test | Sensitivity | Specificity | PPV | NPV | LR for + test (95% CI) | LR for - test (95% CI) | FP | FN |
|-----------------|-------------|-------------|-----|-----|-----------------------|------------------------|-----|-----|
| **For HTD**     |             |             |     |     |                       |                        |     |     |
| Any notch       | 33%         | 91%         | 5.5% | 97.5% | 3.66                  | 0.73                   | 17.8% | 66.6% |
| Bilateral notch | 33.3% %     | 88%         | 8.3% | 97.6% | 2.74                  | 0.76                   | 11.57% | 66.6% |
| **For FGR**     |             |             |     |     |                       |                        |     |     |
| Any notch       | 60%         | 83.8%       | 15% | 97.5% | 3.5                   | 1.5                    | 16.12% | 40% |
| Bilateral notch | 60%         | 90.32%      | 25% | 97% | 6                     | 0.4                    | 9.6% | 40% |
IN GROUP II (LOW RISK)

- 72% of cases belonged to 21-30 yrs, 25% belonged to 18-20 yrs, 3% of cases belonged to 31-35 yrs of age.
- 40% cases were multigravida, 60% of cases were primigravida.
- Bilateral notch was present in 12.24% of cases, 6.12% of cases had unilateral notch.
- 8.3% had HTD, 16.7% had FGR, 16.7% had both HT/FGR, 41.7% had cesarean delivery, 16.7% had preterm delivery, 41.7% had abnormal perinatal outcome in cases with bilateral diastolic notches.
- 8.3% had FGR, 16.7% had both FGR and HT, 16.7% had cesarean delivery, 33.3% had preterm delivery and 16.7% had abnormal perinatal outcome in cases with unilateral outcome.
- 1.2% had abnormal outcome with absent notch.
- In this study in Group II, there is significant association between notch and parity, both FGR and HT, perinatal outcome. Insignificant association between notch and HT, FGR, mode of delivery, and gestational age at delivery.
CONCLUSION

* Prevention is better than cure; though preeclampsia is not a preventable disease; early prediction helps in increased fetal surveillance and timely interventions.

* From the study it is concluded that in Group I (High risk), in case of bilateral notches there is increased risk of preeclampsia, FGR, preterm delivery and abnormal perinatal outcome compared to cases with unilateral notches and absent notches.

* In Group II (low risk) cases also, bilateral notches are associated with increased risk of preeclampsia, FGR, Preterm delivery and abnormal perinatal outcome compared to unilateral and absent notches.

* In both Group I and Group II, bilateral diastolic notch was associated with poor prognosis.

* It is better to do Uterine artery doppler study, along with Target scan at 20-22 weeks of gestation, thereby both anomalies of fetus and risk of preeclampsia, FGR can be predicted in the same visit.

* Prediction value of Uterine artery doppler study is increased by doing the test along with serum beta HCG, PAPP A, inhibin A.

* Cost of the test is the drawback in doing the test in government setup.
★ From the study, it is concluded that in Group I and II, those cases with bilateral notch require more fetal surveillance and timely intervention compared to unilateral and absent notch.

★ Cases with absent notches require only routine checkup and not frequent checkup.
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PROFORMA

Name : 
Age : 
IP No : 
Unit : 
Address : 

Parity : 
Occupation : 
LMP : 
EDD : 

Any specific complaints : 

Menstrual History :
Marital History :
Obstetric History :
Personal / past History :
Family History :
General Examination :

Height : Weight :
Vital signs :
PR : BP : CVS : RS :
Obstetric examination :

Investigations :

1. Urine Analysis :

2. Blood :

3. USG Obstetrics :

4. Doppler - Uterine Artery :
   Presence of Notch - Unilateral :
     - Bilateral
   Absence of notch :

5. Development of HTD/FGR :

6. Mode of delivery :
   Vaginal :
   Caesarean :

7. Gestational age at delivery :

8. Perinatal outcome :
   Birth weight :
   APGAR :
   NICU Admission :
| S.No. | Name       | Parity | Age | Notch | Normal (No Hypertension, Fgr) | Gestational Hypertension | Mild preeclampsia | Severe preeclampsia | FGR | HT and FGR | Vaginal delivery | LSCS | Preterm delivery | Term delivery | Normal Perinatal Outcome | Abnormal Perinatal Outcome |
|-------|------------|--------|-----|-------|--------------------------------|--------------------------|---------------------|--------------------|-----|------------|-------------------|------|------------------|--------------|---------------------|--------------------------|
| 1     | vijaya     | M      | 20  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 2     | mallika    | M      | 18  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 3     | marri      | M      | 21  | 0     | 0     | B                               | 0                        | 0                   | 0                  | FGR| 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 4     | ranjana    | M      | 22  | 0     | 0     | B                               | 0                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 5     | chitra     | M      | 18  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 6     | vasaki     | M      | 19  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 7     | karupayee  | M      | 23  | 0     | 0     | B                               | 0                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 8     | buvana     | M      | 17  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 9     | rajalakshmi| M      | 18  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 10    | sudha      | M      | 24  | 0     | 0     | B                               | 0                        | N                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 11    | veeralakshmi| M   | 23  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 12    | sundarammal| M      | 25  | 0     | 0     | B                               | 0                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 13    | durgadevi  | M      | 24  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 14    | shanthi    | M      | 26  | 0     | 0     | B                               | 0                        | N                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 15    | soniya     | M      | 19  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 16    | bharathi   | M      | 18  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 17    | malar      | M      | 27  | 0     | 0     | B                               | 0                        | N                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 18    | pandeswari | M      | 20  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 19    | mathi      | M      | 19  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 20    | sujatha    | M      | 28  | 0     | 0     | B                               | 0                        | N                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 21    | valiyammal | M      | 29  | 0     | 0     | B                               | 0                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 22    | priyanka   | M      | 26  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 23    | kavya      | M      | 27  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 24    | kumari     | M      | 29  | 0     | 0     | B                               | 0                        | N                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 25    | petchiammal| M      | 30  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 26    | malliga    | M      | 26  | 0     | 0     | B                               | 0                        | GHT                 | 0                   | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 27    | malar      | M      | 27  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 28    | rajaswari  | M      | 26  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 29    | ramya      | M      | 25  | 0     | 0     | B                               | 0                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 30    | anbarasi   | M      | 24  | 0     | 0     | B                               | 0                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 31    | anu        | M      | 23  | 0     | 0     | B                               | 0                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 32    | augusta    | M      | 23  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 33    | beula      | M      | 22  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 34    | kalaiselvi | M      | 21  | 0     | 0     | B                               | 0                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 35    | sumathy    | M      | 30  | 0     | 0     | B                               | 0                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 36    | ramalkshmi | M      | 25  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 37    | sankari    | M      | 33  | 0     | 0     | B                               | 0                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 38    | amutha     | M      | 27  | 0     | 0     | A                               | N                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| 39    | pattulakshmi| M | 33  | 0     | 0     | B                               | 0                        | 0                   | 0                  | 0   | 0          | V                 | 0    | 0                | T            | NPO                 | 0                         |
| Name       | Age | Sex | Type | Marital Status | Children | Education | Both | Both | Other | Notes |
|------------|-----|-----|------|----------------|----------|-----------|------|------|-------|-------|
| Aruna      | 32  | B   | 0    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Banu       | 31  | B   | 0    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Eshkiammal | 22  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Mohammed Nisha | 28  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Viji       | 32  | B   | 0    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Kamalam    | 33  | B   | 0    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Nageeshwari | 30  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Selvi      | 34  | U   | 0    | 0             | 0        | FGR       | BOTH | V    | L     |       |
| Valli      | 25  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Patna      | 30  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Sorna      | 28  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Latha      | 26  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Divya      | 24  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Rathi      | 22  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Varalakshmi | 21  | U   | A    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Kavitha    | 33  | U   | A    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Aathilakshmi | 22 | A   | N    | 0             | 0        | GHT       | 0    | 0    |       |       |
| Murugammal | 25  | A   | 0    | 0             | 0        | GHT       | 0    | 0    |       |       |
| Lakshmi    | 26  | A   | 0    | 0             | 0        | GHT       | 0    | 0    |       |       |
| Kavitha    | 28  | A   | 0    | 0             | 0        | GHT       | 0    | 0    |       |       |
| Kalianmal  | 27  | A   | 0    | 0             | 0        | GHT       | 0    | 0    |       |       |
| Knagakalakshmi | 29 | A   | 0    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Radha      | 30  | A   | 0    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Mookayee   | 27  | B   | 0    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Pappa      | 19  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Madathi    | 20  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Vinotha    | 30  | B   | 0    | 0             | 0        | MP        | 0    | 0    |       |       |
| Raji       | 22  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Rani       | 35  | B   | 0    | 0             | 0        | FGR       | BOTH | V    | 0     |       |
| Meena      | 23  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Priyanka   | 25  | A   | 0    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Sardha     | 28  | A   | 0    | 0             | 0        | MP        | 0    | 0    |       |       |
| Mookayee   | 28  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Moupidathi | 29  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Annalakshmi | 27  | B   | 0    | 0             | 0        | GHT       | 0    | 0    |       |       |
| Murugammal | 29  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Vanishree  | 28  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Kumari     | 22  | B   | 0    | 0             | 0        | FGR       | BOTH | V    | 0     |       |
| Sundari    | 25  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Subashini  | 24  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Thilaga    | 31  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
| Mariannmal | 21  | A   | N    | 0             | 0        | FGR       | 0    | 0    |       |       |
|   | M- Multigravida | U- Unilateral | B-Bilateral | A-absent+B-A | N-Normal (No Hypertension, Fgr) | G-Gestational Hypertension | MP-Mild preeclampsia | SP-Severe preeclampsia | FGR-Fetal Growth Restriction | BOTH- FGR and Hypertension | V-Vaginal delivery | L-LSCS | P-Preterm delivery | T-Term delivery | NPO-Normal Perinatal Outcome | APO-Abnormal Perinatal Outcome |
|---|----------------|---------------|------------|-------------|------------------------------|-----------------------|-----------------------|----------------------|------------------------|--------------------------|-----------------|--------|----------------|--------------|--------------------------|-----------------------------|
| 82| annilkshmi    | M              | 23         | 0           | 0                           | A                     | N                     | 0                    | 0                      | 0                        | 0               | 0      | 0               | 0             | 0                       | 0                           |
| 83| krithiga      | M              | 32         | 0           | B                           | 0                     | 0                     | 0                    | 0                      | 0                        | SP              | 0      | 0               | 0             | 0                       | APO                         |
| 84| sabeena       | M              | 29         | 0           | 0                           | A                     | N                     | 0                    | 0                      | 0                        | 0               | 0      | T               | 0             | NPO                      | 0                           |
| 85| sudali        | M              | 34         | 0           | B                           | 0                     | 0                     | 0                    | 0                      | 0                        | SP              | 0      | 0               | 0             | 0                       | APO                         |
| 86| valar         | M              | 24         | 0           | 0                           | A                     | N                     | 0                    | 0                      | 0                        | 0               | 0      | T               | 0             | NPO                      | 0                           |
| 87| parvathy      | M              | 34         | 0           | B                           | 0                     | 0                     | 0                    | 0                      | 0                        | MP              | 0      | 0               | 0             | 0                       | T                           |
| 88| santhanmrni   | M              | 24         | 0           | 0                           | A                     | N                     | 0                    | 0                      | 0                        | 0               | 0      | T               | 0             | NPO                      | 0                           |
| 89| sabeena       | M              | 26         | 0           | A                           | N                     | 0                     | 0                    | 0                      | 0                        | 0               | 0      | T               | 0             | NPO                      | 0                           |
| 90| sumitha       | M              | 31         | 0           | B                           | 0                     | 0                     | 0                    | 0                      | 0                        | FGR             | 0      | T               | 0             | NPO                      | 0                           |
| 91| indira        | M              | 33         | U           | 0                           | 0                     | 0                     | 0                    | 0                      | 0                        | MP              | 0      | T               | 0             | APO                      | 0                           |
| 92| kumari        | M              | 22         | 0           | 0                           | A                     | N                     | 0                    | 0                      | 0                        | 0               | V      | T               | 0             | NPO                      | 0                           |
| 93| booma         | M              | 23         | 0           | 0                           | A                     | N                     | 0                    | 0                      | 0                        | 0               | V      | T               | 0             | NPO                      | 0                           |
| 94| gomathy       | M              | 35         | U           | 0                           | 0                     | 0                     | GHT                  | 0                      | 0                        | 0               | 0      | 0               | P             | T                       | 0                           |
| 95| chitra        | M              | 27         | 0           | 0                           | A                     | N                     | 0                    | 0                      | 0                        | 0               | V      | T               | 0             | NPO                      | 0                           |
| 96| umrani        | M              | 29         | 0           | 0                           | A                     | N                     | 0                    | 0                      | 0                        | 0               | V      | T               | 0             | NPO                      | 0                           |
| 97| esakkiammal   | M              | 35         | U           | 0                           | 0                     | 0                     | 0                    | 0                      | 0                        | FGR             | 0      | T               | 0             | APO                      | 0                           |
| 98| ramu          | M              | 24         |             |                             |                        |                        |                      |                        |                          |
| 99| sudha         | M              | 23         |             |                             |                        |                        |                      |                        |                          |
|100| pandaram      | M              | 26         |             |                             |                        |                        |                      |                        |                          |
| S.No | Name         | Parity | Age | Unilateral | Bilateral | Absent | HT and GFR | vaginal delivery | preterm delivery | term delivery | Normal Perinatal Outcome | Abnormal Perinatal Outcome |
|------|--------------|--------|-----|------------|-----------|--------|------------|------------------|------------------|--------------|--------------------------|-----------------------------|
| 1    | krishnaveni  | PR     | 19  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 2    | vanitha      | PR     | 18  | U          | 0         | 0      | N          | 0                | 0                | 0            | V                        | 0                           |
| 3    | rajani       | M      | 32  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 4    | madhu        | M      | 33  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 5    | palaniyammal | PR     | 18  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 6    | munjala      | M      | 25  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 7    | petchiammal  | PR     | 19  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 8    | mary         | M      | 24  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 9    | suthanam     | M      | 26  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 10   | vani         | PR     | 20  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 11   | vasanithi    | M      | 21  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 12   | boothapandichi| PR    | 17  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 13   | vellathai    | PR     | 16  | U          | 0         | 0      | N          | 0                | 0                | 0            | V                        | 0                           |
| 14   | sornam       | M      | 27  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 15   | ponezaki     | M      | 29  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 16   | usha         | PR     | 17  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 17   | valliamml    | PR     | 20  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 18   | lakshmi      | M      | 24  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 19   | pandiyanmal  | PR     | 19  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 20   | amutha       | PR     | 20  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 21   | sundari      | M      | 23  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 22   | kousalya     | PR     | 28  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 23   | sudali       | PR     | 23  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 24   | kamagi       | PR     | 25  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 25   | ranjitham    | M      | 25  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 26   | kodi         | PR     | 20  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 27   | ganga        | M      | 20  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 28   | vennathhi    | M      | 25  | 0          | B         | 0      | 0          | 0                | SP               | FGR          | 1                         | 0                           |
| 29   | viji         | M      | 24  | 0          | B         | 0      | 0          | 0                | MP               | FGR          | 1                         | 0                           |
| 30   | meena        | PR     | 22  | 0          | B         | 0      | 0          | 0                | 0                | 0            | V                        | 0                           |
| 31   | sathyaa      | M      | 22  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 32   | ishiba       | M      | 21  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 33   | nagalakshmi  | PR     | 23  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 34   | indumathy    | M      | 30  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 35   | vani         | M      | 34  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 36   | revathi      | PR     | 30  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 37   | packiam      | PR     | 29  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 38   | shanthy      | PR     | 27  | 0          | B         | 0      | N          | 0                | 0                | 0            | V                        | 0                           |
| 39   | vidya        | M      | 26  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 40   | shannugusundari| PR | 26  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 41   | nabeesha     | PR     | 22  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 42   | arumugaselvi | PR     | 27  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 43   | nannya       | PR     | 29  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 44   | lalitha      | M      | 26  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 45   | ramakrishna  | PR     | 26  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| 46   | tamiselvi    | PR     | 23  | 0          | 0         | A      | N          | 0                | 0                | 0            | V                        | 0                           |
| No. | Name            | PR | Date | Gender | Address | City | State | Occupation | Status  |
|-----|-----------------|----|------|--------|---------|------|-------|------------|---------|
| 47  | eskiammal        | PR22 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 48  | sugeetha         | PR24 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 49  | pandianmal       | PR26 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 50  | anulapushpam     | M   | 21   | 0      | A      | N    | 0     | 0          | 0       |
| 51  | perachi          | PR20 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 52  | poongodi         | PR17 | 0    | 0      | N      | 0     | 0     | 0          | 0       |
| 53  | guruvammal       | M   | 23   | 0      | A      | N    | 0     | 0          | 0       |
| 54  | avudaiammal      | PR18 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 55  | mariammal        | PR19 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 56  | andal selvi      | M   | 22   | 0      | A      | N    | 0     | 0          | 0       |
| 57  | muthumari        | M   | 28   | 0      | A      | N    | 0     | 0          | 0       |
| 58  | anitha           | PR17 | 0    | 0      | N      | 0     | 0     | 0          | 0       |
| 59  | malliga          | M   | 30   | 0      | A      | N    | 0     | 0          | 0       |
| 60  | kamala           | M   | 23   | 0      | A      | N    | 0     | 0          | 0       |
| 61  | usha             | PR18 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 62  | mury             | PR19 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 63  | rini             | M   | 25   | 0      | A      | N    | 0     | 0          | 0       |
| 64  | kavitha          | PR25 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 65  | aandal selvi     | PR27 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 66  | natchiyar        | PR29 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 67  | arumugam         | M   | 30   | 0      | A      | N    | 0     | 0          | 0       |
| 68  | jyothi           | M   | 28   | 0      | A      | N    | 0     | 0          | 0       |
| 69  | kothai           | PR18 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 70  | manmegalai       | PR19 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 71  | hangam           | M   | 22   | 0      | A      | N    | 0     | 0          | 0       |
| 72  | murugamam        | PR19 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 73  | sankaranamal      | M   | 27   | 0      | B      | N    | 0     | 0          | 0       |
| 74  | sarya            | PR18 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 75  | ragi             | PR19 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 76  | amali            | M   | 26   | 0      | B      | N    | 0     | 0          | 0       |
| 77  | shakti           | PR28 | 0    | 0      | B      | N    | 0     | 0          | 0       |
| 78  | gomathi          | PR25 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 79  | seenianmal       | M   | 23   | 0      | A      | N    | 0     | 0          | 0       |
| 80  | malathithi       | PR26 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 81  | jeyalakshmi      | PR24 | 0    | 0      | B      | N    | 0     | 0          | 0       |
| 82  | nuokalammal      | PR21 | 0    | 0      | B      | N    | 0     | 0          | 0       |
| 83  | ponnulai         | M   | 30   | 0      | A      | N    | 0     | 0          | 0       |
| 84  | mageshwari       | PR28 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 85  | balammar         | PR22 | 0    | 0      | B      | N    | 0     | 0          | 0       |
| 86  | vimala           | PR30 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 87  | padnavathy       | M   | 29   | 0      | A      | N    | 0     | 0          | 0       |
| 88  | thulasii         | M   | 23   | 0      | A      | N    | 0     | 0          | 0       |
| 89  | rajeshwari       | PR24 | 0    | 0      | B      | N    | 0     | 0          | 0       |
| 90  | subbulakshmi     | PR26 | 0    | 0      | B      | N    | 0     | 0          | 0       |
| 91  | jeyachitra       | M   | 25   | 0      | A      | N    | 0     | 0          | 0       |
| 92  | arulai           | M   | 27   | 0      | A      | N    | 0     | 0          | 0       |
| 93  | fathima          | PR24 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 94  | rajalakshmi      | PR26 | 0    | 0      | A      | N    | 0     | 0          | 0       |
| 95  | diana            | M   | 29   | 0      | U      | 0    | 0     | 0          | 0       |
| 96  | nallathai        | PR28 | 0    | 0      | A      | N    | 0     | 0          | 0       |
|    |    | V   | M  | T  | L  | P  | B  | U  | A  | N  | G  | FGR | BOTH | V  | MP | SP  | FGR | BOTH | V  | L  | P  | T  | NPO | APO |
|----|----|-----|----|----|----|----|----|----|----|----|----|-----|------|----|----|-----|-----|------|----|----|----|----|-----|-----|
| 97 | veni | M   | 30 | -  | -  | -  | -  | -  | -  | -  | -  | -   | -    | -  | -  | -   | -   | -    | -  | -  | -  | -  | -   | -   |
| 98 | selvi | PR  | 25 | 0  | 0  | A  | N  | 0  | 0  | 0  | 0  | V   | 0    | 0  | T  | NPO | 0   | NPO  | 0  | -  | -  | -  | -   | -   |
| 99 | antonyammal | PR | 29 | 0  | 0  | A  | N  | 0  | 0  | 0  | 0  | V   | 0    | 0  | T  | NPO | 0   | NPO  | 0  | -  | -  | -  | -   | -   |
| 100| velanammal | M  | 28 | -  | -  | -  | -  | -  | -  | -  | -  | -   | -    | -  | -  | -   | -   | -    | -  | -  | -  | -  | -   | -   |

PR-Primi
M-Multigravida
U-Unilateral
B-Bilateral
A-Absent
N-Normal (No Hypertension, Fgr)
G-gestational Hypertension
MP-mild preeclampsia
SP-severe preeclampsia
FGR-Fetal Growth Restriction
BOTH-FGR and Hypertension
V-Vaginal delivery
L-LSCS
P-Preterm delivery
T-Term delivery
NPO-Normal Perinatal Outcome
APO-Abnormal Perinatal Outcome