International Journal of Medical Science in Clinical Research and Review
Online ISSN: 2581-8945
Available Online at http://www.ijmscrr.in Volume 05|Issue 05 (September-October)|2022|Page: 792-815

Original Research Paper

ROLE OF CEREBROPLACENTAL RATIO OF DOPPLER VELOCIMETRY TO DETERMINE IMMEDIATE PERINATAL OUTCOME IN HYPERTENSIVE DISORDERS OF PREGNANCY IN A TERTIARY CARE HOSPITAL

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Article Received: 20-08-2022 **Revised:** 10-09-2022 **Accepted:** 01-10-2022

Conflict of interest: Nil
Funding: Self
Ethical clearance: By the Institutional ethics committee of Andhra Medical College, Andhra Pradesh, India.

ABSTRACT:

BACKGROUND: Hypertensive disorders are the most common pregnancy related complications with an incidence of 5-10% of all pregnancies and has a substantial impact on mother and perinatal morbidity and mortality. Doppler evaluation of blood flow through the cerebral vessels will allow for the detection of altered cerebral circulation even before significant fetal heart rate changes due to hypoxemia. In this study, we aimed to To study determine immediate perinatal outcome in hypertensive disorders of pregnancy using cerebroplacental ratio by combining vessels like umbilical artery and middle cerebral artery. **METHODOLOGY**: A total of 200 participants are selected sure of their date of the last menstrual period and had regular menstrual cycles previously. Their gestational age is further corroborated by first trimester ultrasound. All the antenatal women planned on induction or presented in labor are examined by routine ultrasound scan and Doppler subsequently. Blood flow velocity waveforms of UA and MCA are obtained with pulsed Doppler ultrasound equipment. The peak systolic, end diastolic and mean velocity are recorded from these vessels and Umbilical artery S/D ratio, PI, RI and Middle Cerebral Artery PI, RI, S/D and CPR are calculated. **RESULTS**: In this study, most of the women were in the age group 20 – 29 yrs. Most of them were gestational hypertension 55%, followed by preeclampsia and eclampsia contributing to 40.5% and the remaining were chronic hypertensives and with superimposed preeclampsia. 16% of the babies had NICU admissions for more than 24hrs for complications like low birth weight with foetal distress, birth asphyxia, meconium aspiration syndrome and-hypothermia. The overall diagnostic accuracy of predicting adverse perinatal outcome is 79.50% with Cerebroplacental ratio and 70% with UA PI which proves the former to be a better predictor. **CONCLUSIONS:** The study states that cerebroplacental ratio is a better tool for assessing immediate perinatal outcome. It has good accuracy for determining low birth weight and APGAR <7. Compared to other methods of foetal monitoring, the use of Doppler has proved to be more sensitive in detecting foetal compromises early and helps in aiding appropriate and timely delivery.

Keywords: Hypertensive disorders of pregnancy, middle cerebral artery, umbilical artery, cerebroplacental ratio, perinatal outcome

INTRODUCTION:

Hypertensive disorders are the most common pregnancy related complications with an incidence of 5-10% of all pregnancies and has a substantial impact on mother and perinatal morbidity and mortality.(1) It is characterized by a syndrome stemming from decreased organ perfusion which is secondary to vasospasm and endothelial pathology.(2)

The earliest pathology is scarce infiltration of spiral arteries by trophoblasts, resulting in their impaired conversion to utero-placental arteries. These changes are considered as a necessary part of placental

development and helps in establishing chorio-decidual blood flow in normal pregnancies.[3] [4] Hypertensive disorders of pregnancy are categorised as Gestational hypertension, Pre-eclampsia, Eclampsia, Chronic hypertension, Chronic hypertension with Superimposed Pre-eclampsia.[5] Intrauterine growth restriction (IUGR) is most common foetal complication of Hypertensive disorders of pregnancy and is due to a lack of normal placental invasion and growth, as well as decreased foetal perfusion.[1] Doppler velocimetry offers a non-invasive, objective and reliable method for assessing placental and foetal cardiovascular functions on the basis of blood flow dynamics measured in uterine, umbilical and foetal arteries. It has become an efficient diagnostic tool for detecting foetal compromise that helps in the management of high risk pregnancies.[6] The utero-placental insufficiency leads to reduced blood supply to the foetus and thus results in foetal growth restriction. The utilization of umbilical artery Doppler shows to improve foetal outcome in foetal growth restriction, in which case there is increased impedance to blood flow in placenta reflected by abnormal umbilical artery velocimetry findings. [7] Inadequate placental perfusion leads to foetal hypoxia and signs of circulation redistribution occurs to the foetal brain, adrenal glands and myocardium with a decrease in blood flow to the foetal kidneys, intestines and lower extremities which is considered as a compensatory mechanism.[8] Doppler evaluation of blood flow through the cerebral vessels will allow for the detection of altered cerebral circulation even before significant fetal heart rate changes due to hypoxemia. Middle cerebral artery is the most accessible vessel and is reported to demonstrate reduction in the Pulsatility index at the onset of hypoxemia.[9] Studies have shown that brain sparing effect reaches its maximum by 2-3 weeks before late decelerations appear on cardio-tocography. This implies that the middle cerebral artery blood flow alterations in the group of patients with a high risk for unfavourable pregnancy outcome can be identified 2-3 weeks prior to delivery.[2] [8] Doppler ultrasound indices such as cerebroplacental ratio (CPR) evaluation are commonly used where CPR is calculated as the absolute ratio between the Doppler pulsatility indices (PIs) of foetal middle cerebral artery (MCA) and umbilical artery (UA) or as the ratio between the corresponding multiples of the median (MoM) for the respective gestational age.[10,11] It enables us to assess the foetal response to hypoxia by detecting blood flow distribution pattern in placento-umbilical and feto-cerebral circulations. With progression of gestational age, the resistance in foetal circulation gradually decreases. The presence of one or more of the following conditions is defined as an adverse perinatal outcome - foetal distress as evidenced by foetal bradycardia or persistent tachycardia requiring caesarean section or instrumental delivery, meconium stained liquor, APGAR score of < 7 at 5 minutes, neonatal complications such as meconium aspiration syndrome or respiratory distress syndrome, admission to neonatal intensive care unit (NICU) and perinatal mortality.[12] By combining multiple vessels, like umbilical artery, middle cerebral artery and uterine artery the sensitivity of the Doppler studies can be significantly increased. Doppler in the feto-placental circulation helps in not only monitoring of compromised fetus but also can help in predicting perinatal morbidity.[13] The present study was conducted to determine immediate perinatal outcome in hypertensive disorders of pregnancy using Cerebroplacental ratio.

Table: 1. REFERENCE RANGE FOR UMBILICAL ARTERY PULSATILITY INDEX (PI) SAMPLED AT FREE LOOP FROM 32 TO 40 WEEKS [14]

Gestational Age(weeks)	**95th centile**
32	1.25
33	1.22
34	1.20
35	1.18
36	1.16
37	1.14

38	1.12
39	1.10
40	1.09

Table 2 REFERENCE RANGE FOR MIDDLE CEREBRAL ARTERY PULSATILITY INDEX FROM 32 TO 39 WEEKS [(14)]

Gestational Age(weeks)	**5th centile**
32	1.61
33	1.58
34	1.53
35	1.47
36	1.39
37	1.30
38	1.20
39	1.10

AIMS AND OBJECTIVES:

AIM:

To determine the immediate perinatal outcome in hypertensive disorders of pregnancy using cerebroplacental ratio.

OBJECTIVES:

1. To evaluate the immediate perinatal outcome using cerebroplacental ratio which is the ratio of pulsatility index of fetal middle cerebral artery and umbilical artery in hypertensive disorders of pregnancy.
2. To compare the predictive value of umbilical artery pulsatility index with cerebroplacental ratio.

METHODOLOGY:

After proper counselling and obtaining informed consent from each antenatal mother selected in the study population, detailed history taking and clinical examinations are performed. All the antenatal women are examined by routine ultrasound scan and Doppler subsequently. Doppler indices are calculated using the specified software supplied within the Doppler equipment. The average values of at least three consecutive waveforms are calculated. All participants selected are sure of their date of the last menstrual period and had regular menstrual cycles previously. Their gestational age is further corroborated by first trimester ultrasound. When a discrepancy of more than seven days is detected, first trimester ultrasound is used to calculate gestational age. Women selected for the study are subjected to complete general, physical, obstetric and pelvic examinations. Regular obstetric scan, foetal parameters obtained, AFI assessed, biweekly NST done. Blood flow velocity waveforms of UA and MCA are obtained with pulsed Doppler ultrasound equipment. The peak systolic, end diastolic and mean velocity are recorded from these vessels and Umbilical artery S/D ratio, PI, RI and Middle Cerebral Artery PI, RI, S/D and CPR are calculated.

Umbilical artery Doppler technique: The transducer is positioned on the pregnant mother's abdomen overlying the foetus and the waveforms from the umbilical artery and vein are adjusted to acquire the distinctive waveforms. An ultrasound scan is performed with a pulsed wave Doppler device, a free-floating section of the cord is located, and the Doppler sample volume is placed over the artery and vein, parallel to the blood flow. Colour-flow mapping with low-pass filter was set at 50Hz. The angle of the foetal Doppler insonation should be kept to < 45°. This gives an optimal umbilical artery Doppler recording.[(15)] With foetal inspiration (during which the foetal abdominal wall draws inward), umbilical venous blood flow increases, and with expiration, it decreases (during which the wall moves outward). There is also breathing-related modulation of arterial pulsatility and umbilical artery Doppler studies should be avoided during foetal breathing. Following the acquisition of waveforms, at least three waveforms are averaged and

impedance indices are computed.. PI values above the 95th percentile were assumed abnormal.[16]

Middle Cerebral Artery (MCA) Doppler technique: At the level of the biparietal diameter, a transverse view of the foetal brain is acquired (BPD). The transducer is advanced to the level of the lesser wing of the sphenoid bone to locate the base of the skull. Using color flow imaging, the middle cerebral artery can be seen as a major lateral branch of the circle of Willis. It runs anterolaterally at the borderline between the anterior and the middle cerebral fossae. The pulsed Doppler gate is placed over the middle portion of the MCA to obtain flow velocity waveforms. Using color-flow mapping with low-pass filter was set at 50Hz, the angle of insonation should be restricted at a minimum of 15 degrees.[17] During the studies, the transducer should be used with caution to apply modest pressure to the maternal abdomen, because cerebral arterial waveforms are altered when the foetal head is compressed. Doppler wave forms were acquired. PI levels below the 5th percentile are assumed abnormal.[16]

- The cerebroplacental ratio (CP) (PI ratio of the middle cerebral artery to the umbilical artery) is calculated.
- Immediate perinatal outcomes are analyzed based on

a. Colour of the liquor
b. APGAR at 5 mins
c. Weight of the baby
d. Admission to neonatal intensive care unit(NICU)
e. Perinatal mortality if any.

MATERIALS AND METHODS:

Study Design: Prospective Observational Study

Study Period: Dec 2019 to Aug 2021

Study Setup: Pregnant women with hypertension attending Dept of Obstetrics and Gynaecology, KGH, Visakhapatnam

Sample Size: A sample of 200 cases.

Inclusion Criteria:

- Pregnant women of age >18yrs with hypertension who are eligible to give consent for the study.
- Pregnant women ≥ 32 and ≤ 40 weeks period of gestation with hypertension.
- Singleton pregnancies
- Cephalic presentation
- Pregnancies with gestational age calculated according to Last Menstrual Period with early scans corresponding.
- Pregnant women who are willing to participate in the study are included.

Exclusion criteria:

- Gestational age uncertain.
- Polyhydramnios.
- Women with multiple pregnancies.
- Congenital foetal anomalies.
- Antepartum haemorrhage.
- Previous caesarean section.
- Fetal malpresentation.

PARAMETERS STUDIED:

Maternal:

1. Age
- <19yrs
- 20-29yrs
- >30yrs

2. Parity
- Primipara
- Multipara

3. Gestational Age at delivery
- ≥32 - <34weeks
- ≥34 - <37weeks
- ≥37weeks

4. Pregnancy complications
- Gestational hypertension
- Preeclampsia/Eclampsia
- Chronic hypertension
- Chronic hypertension with superimposed preeclampsia

5. Mode of delivery
- NVD
- LSCS

Fetal:

1. Weight of the baby
- ≥2.5kg
- ≥1.5 - <2.5kg
- <1.5kg

2. Duration of NICU stay
- <24hrs
- >24hrs

3. APGAR @5mins:
- 8-10
- 4-7
- <4

4. CTG
- Reassuring
- Non reassuring

5. Colour of liquor:
- Clear
- Meconium stained

ETHICAL CONSIDERATIONS:

The Institutional Ethical Committee clearance was obtained. Written and informed consent was obtained from every individual of the study. Confidentiality of every patient is maintained.

STATISTICAL METHODS:

The data obtained were entered in Microsoft Excel spreadsheet and analysis were done using Statistical Package for Social Sciences (SPSS) version 26.0. Descriptive analysis of data was done calculating mean, median and standard deviation. Categorical variables were expressed as frequencies and percentages. P<0.005 were considered statistically significant. Sensitivity, specificity, positive predictive

value, negative predictive value and diagnostic accuracy were calculated.

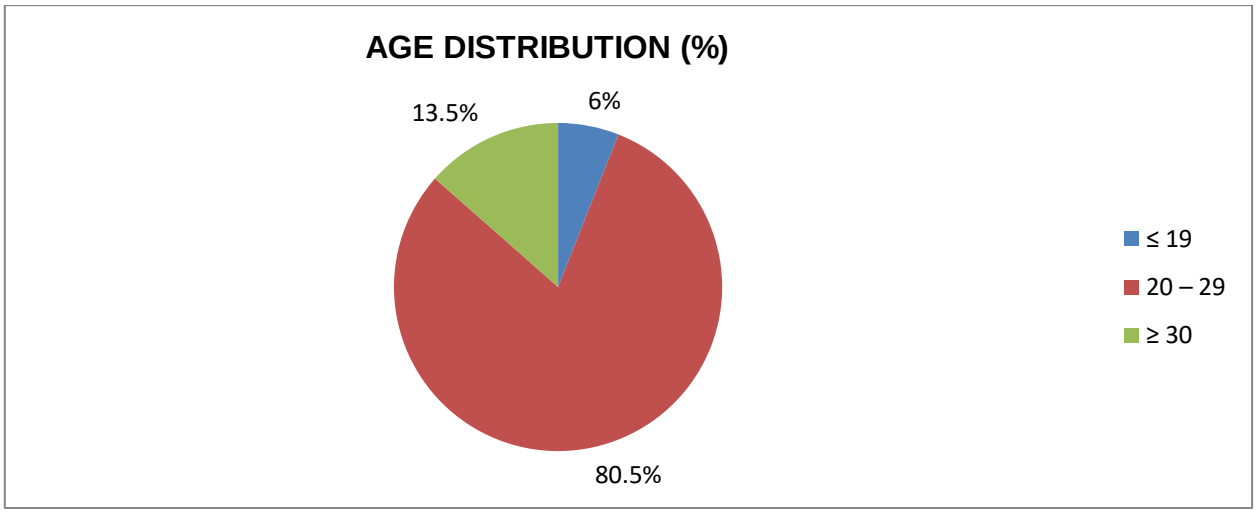
OBSERVATIONS AND RESULTS:

AGE DISTRIBUTION:

Table: 3. AGE DISTRIBUTION

AGE (YEARS)	n	%
≤ 19	12	6
20 – 29	161	80.5
≥ 30	27	13.5
Total	200	100
Mean ± SD	25.46 ± 3.48 years	

Figure: 1. PIE DIAGRAM ON AGE DISTRIBUTION



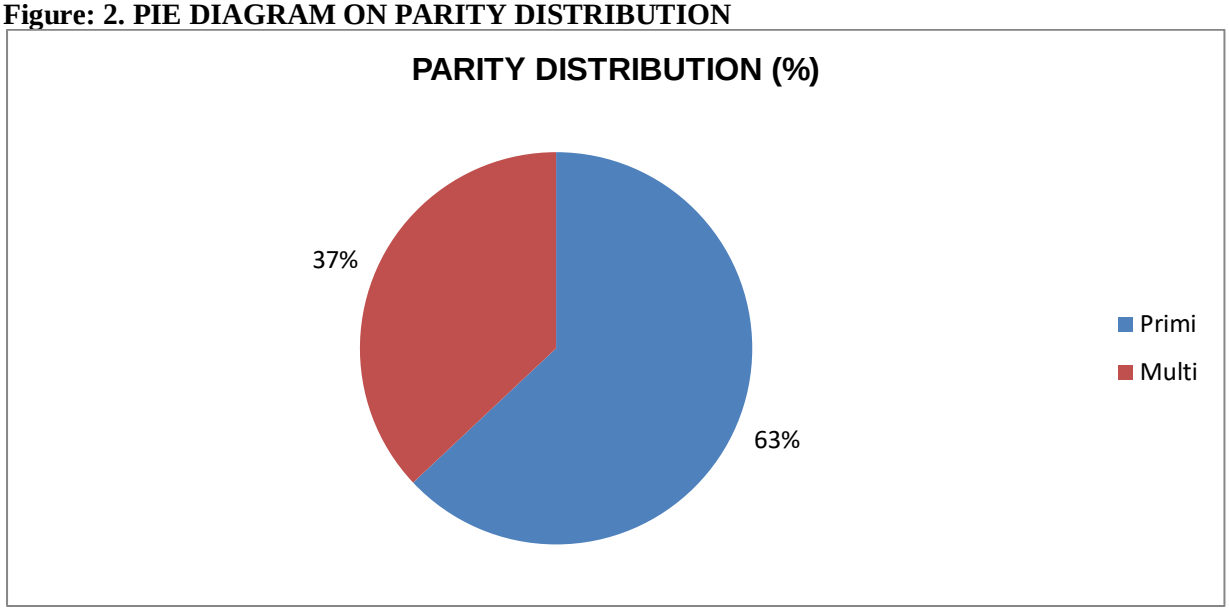
Out of 200 patients included in the study 12 were below 19 yrs ,161 were between 20 – 29 yrs , 27 above 30 yrs. The mean age of the study group was 25.4 with a standard deviation of 3.48.

PARITY:

Table: 4. PARITY DISTRIBUTION

PARITY	n	%
Primi	126	63
Multi	74	37
Total	200	100

Figure: 2. PIE DIAGRAM ON PARITY DISTRIBUTION



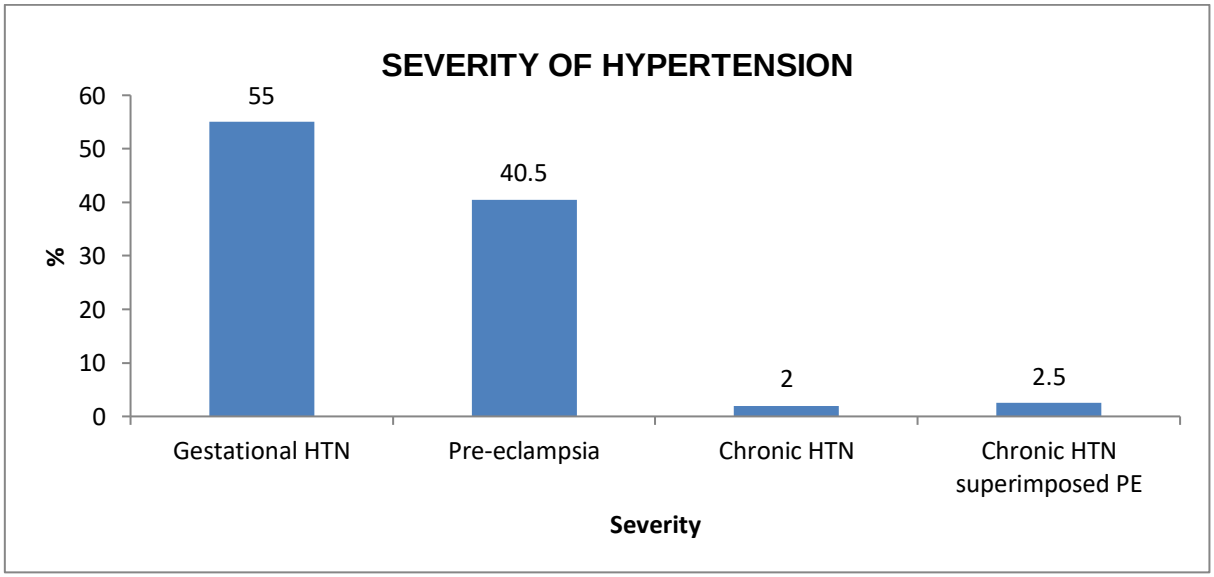
Out of 200 antenatal women, 126 were primi gravida and 74 were multigravida.

BASED ON CATEGORY OF HTN:

Table: 5. DISTRIBUTION BASED ON SEVERITY OF HTN

CATEGORY OF HTN	n	%
Gestational HTN	110	55
Pre-eclampsia/Eclampsia	81	40.5
Chronic HTN	4	2
Chronic HTN superimposed PE	5	2.5
Total	200	100

Figure: 3. DISTRIBUTION BASED ON SEVERITY OF HTN



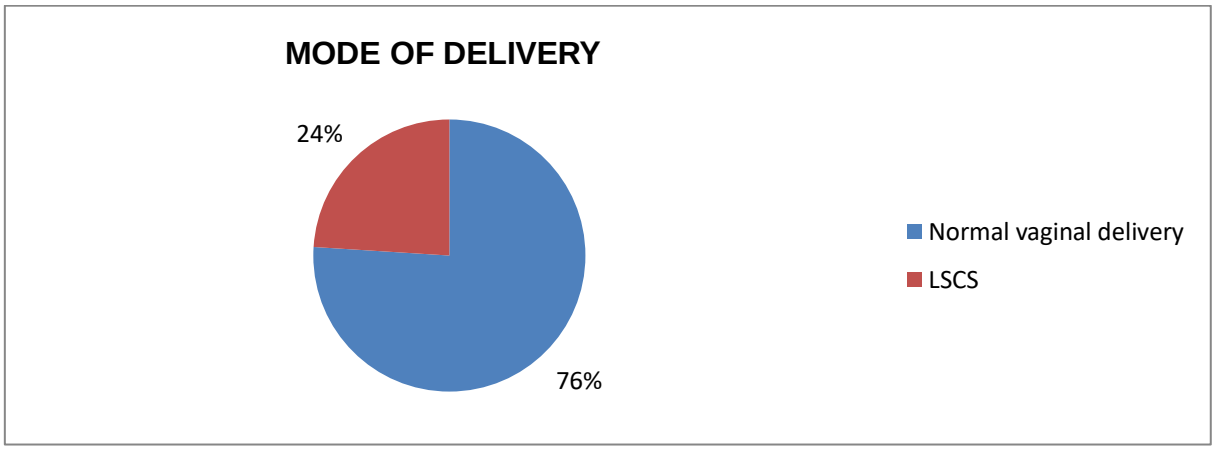
Out of 200 antenatal women, most of them had gestational hypertension 55%, followed by preeclampsia and eclampsia contributing to 40.5% and the remaining were chronic hypertensives and with superimposed preeclampsia.

BASED ON THE MODE OF DELIVERY:

Table: 6: DISTRIBUTION BASED ON MODE OF DELIVERY

MODE OF DELIVERY	n	%
Normal vaginal delivery	152	76
LSCS	48	24
Total	200	100

Figure: 4. DISTRIBUTION BASED ON MODE OF DELIVERY



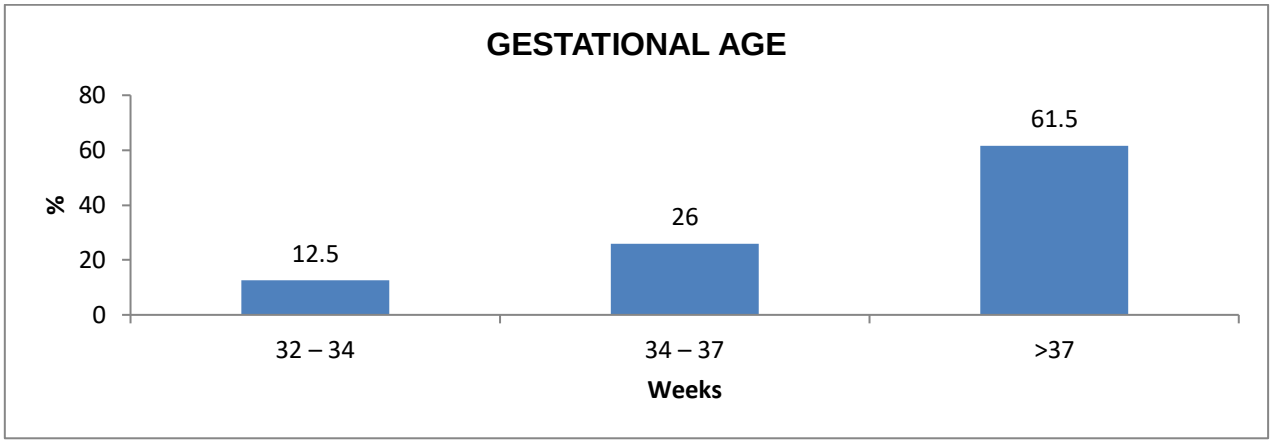
Out of 200 antenatal women, 152 delivered by vaginal route and the remaining 48 required caesarean section. Most common indication for LSCS was failed induction, foetal distress, meconium stained liquor and abnormal Doppler.

BASED ON GESTATIONAL AGE:

Table: 7. DISTRIBUTION BASED ON GESTATIONAL AGE

GESTATIONAL AGE (WEEKS)	n	%
≥32 – <34	25	12.5
≥34 – <37	52	26
≥37	123	61.5
Total	200	100
Mean ± SD	36.9 ± 2.24 weeks	

Figure: 5. DISTRIBUTION BASED ON GESTATIONAL AGE



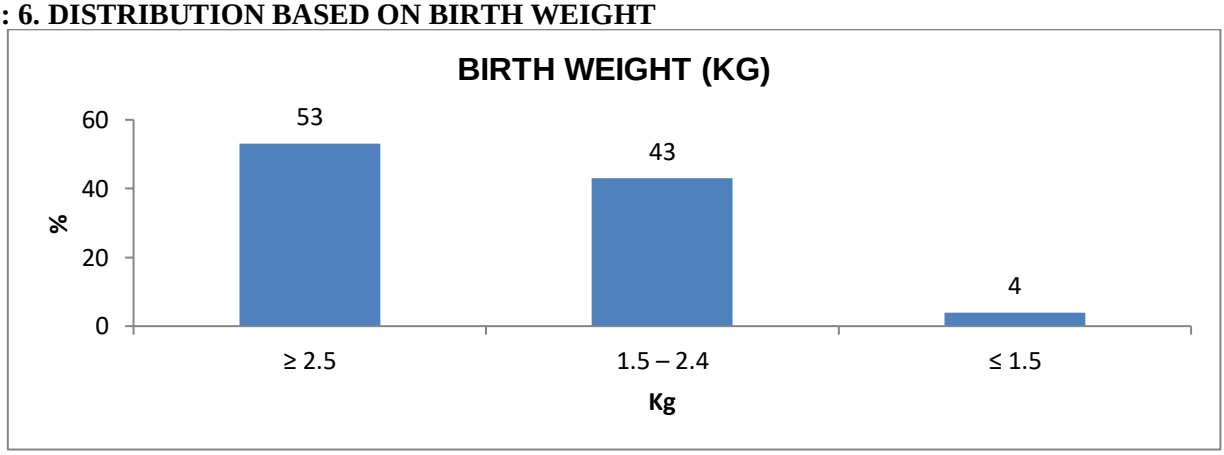
Out of 200 antenatal women, 12.5 % delivered between ≥32 – <34weeks, 26% delivered between ≥34 – <37weeks and 61.5% delivered after 37 weeks. The mean gestational age at delivery was 36.9 weeks with a standard deviation of 2.24.

BASED ON BIRTH WEIGHT:

Table: 8. DISTRIBUTION BASED ON BIRTH WEIGHT

BIRTH WEIGHT (KG)	n	%
≥ 2.5	106	53
1.5 – 2.4	86	43
≤ 1.5	8	4
Total	200	100
Mean ± SD	2.46 ± 0.45kg	

Figure: 6. DISTRIBUTION BASED ON BIRTH WEIGHT



In the present study, out of 200 babies,106 babies weighed more than 2.5kg (53%), 86 babies weighed between 1.5 – 2.4 and 8 babies weighed ≤ 1.5kg. The mean birth weight was 2.46kg with a standard deviation of 0.45kg.

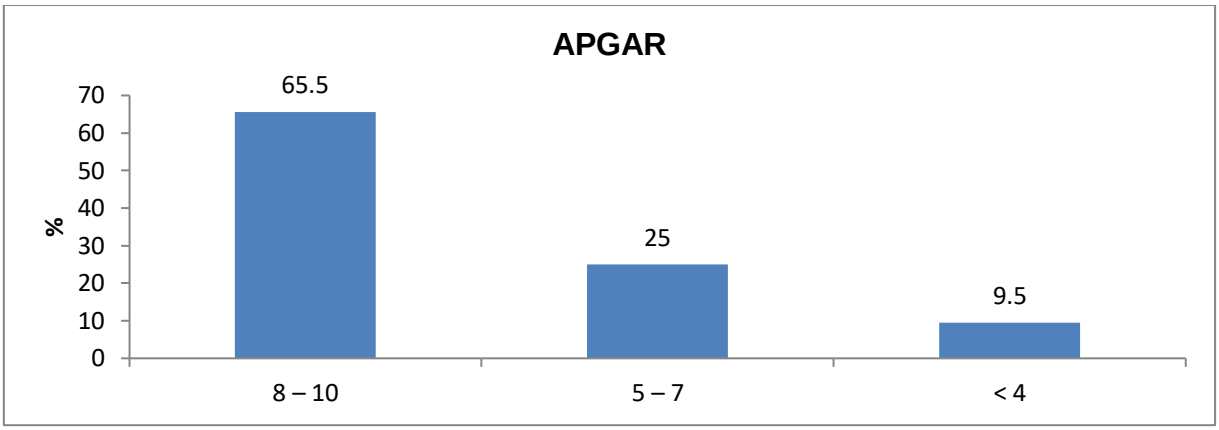
BASED ON APGAR

Table: 9. DISTRIBUTION BASED ON APGAR

APGAR	n	%
8 – 10	131	65.5
5 – 7	50	25
< 4	19	9.5
Total	200	100
Median (range)	8 (2 – 10)	

Table: 10. DISTRIBUTION BASED ON CTG

Figure: 7. DISTRIBUTION BASED ON APGAR SCORE

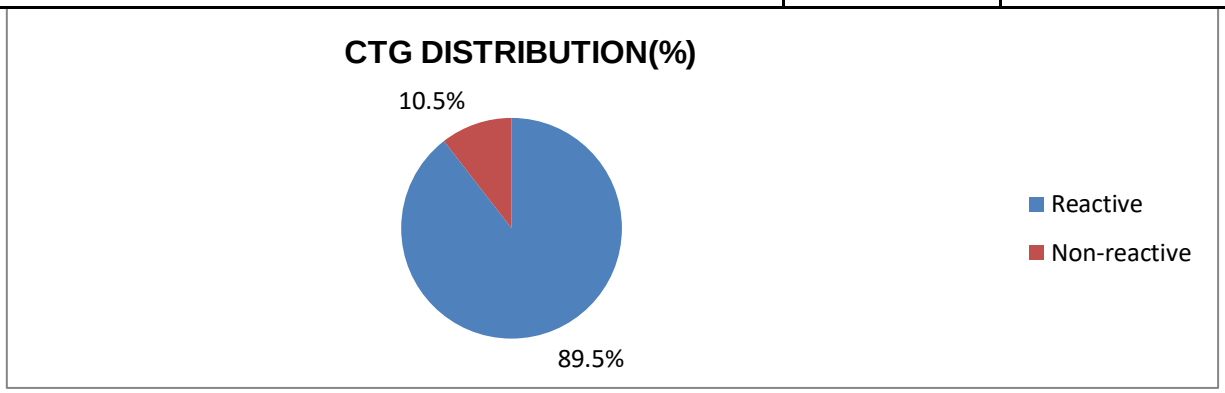


Out of 200 babies, 131 babies had APGAR >7 and 69 babies had APGAR <7. Median APGAR is 8.

BASED ON CTG:

Figure: 8. PIE DIAGRAM ON CTG REACTIVITY

CTG	n	%
Reassuring	179	89.5
Non-reassuring	21	10.5
Total	200	100



In the present study, CTG was found Reactive/Reassuring in 179 (89.5%) cases and Non reactive/Non reassuring in 21(10.5%) cases.

BASED ON NICU STAY:

Table: 11. DISTRIBUTION BASED ON NICU ADMISSIONS

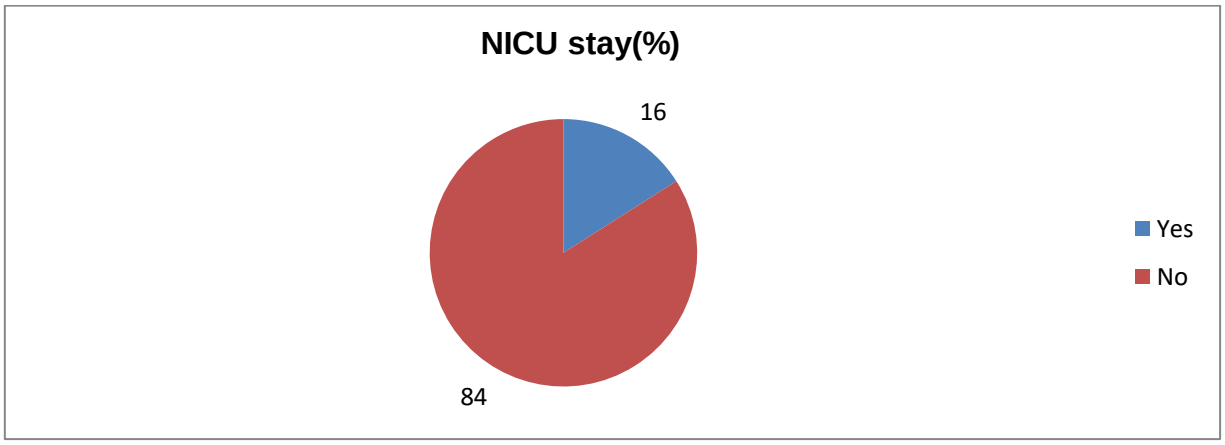
NICU stay	n	%

Yes	32	16
No	168	84

COLOUR OF LIQUOR	n	%
Clear	158	79
Meconium stained liquor	42	21
Total	200	100

Total	200	100

Figure: 9. DISTRIBUTION BASED ON NICU STAY

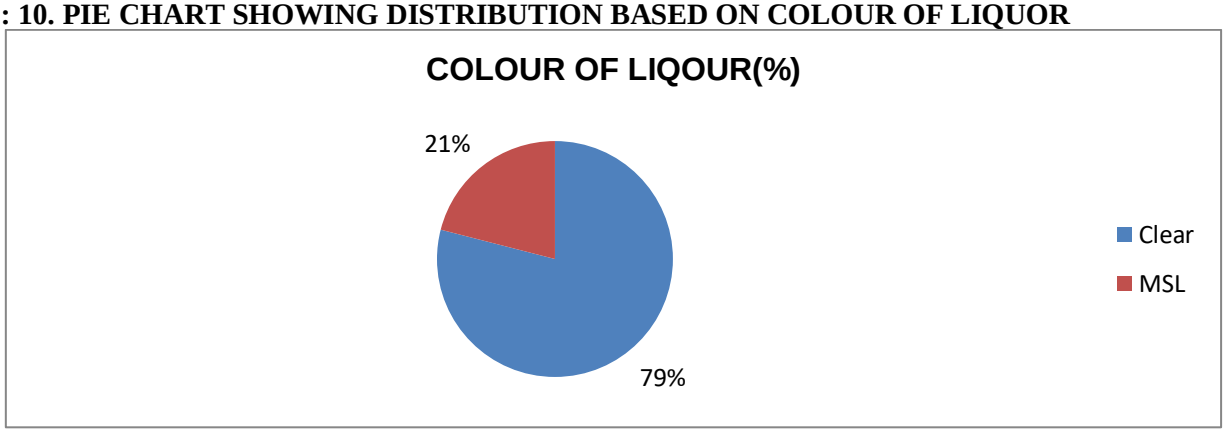


Out of 200 babies delivered, 32 babies required NICU admission for more than 24hrs. Most common complications were low birth weight with foetal distress, birth asphyxia, meconium aspiration syndrome and hypothermia.

BASED ON THE COLOR OF LIQUOR:

Table: 12. DISTRIBUTION BASED ON COLOR OF LIQUOR

Figure: 10. PIE CHART SHOWING DISTRIBUTION BASED ON COLOUR OF LIQUOR



Out of 200 deliveries, 42 babies had meconium stained liquor and 158 babies had clear liquor.

CEREBROPLACENTAL RATIO AND PERINATAL OUTCOME:

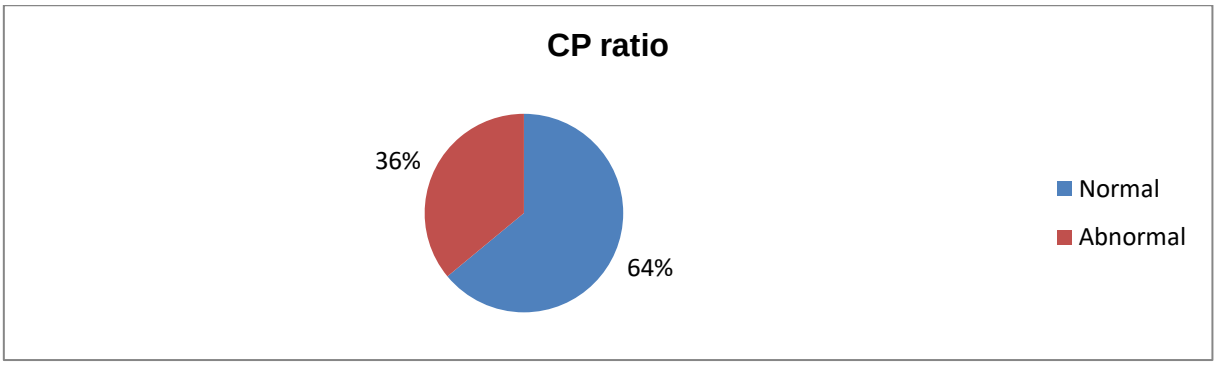
Table: 13. CP RATIO AND PERINATAL OUTCOME

CPR	Birth weight				Total	
	<2.5kg		≥ 2.5kg			
	n	%	n	%	N	%
Abnormal(<1.08)	58	80.6	14	19.4	72	100
Normal (≥1.08)	36	28.1	92	71.9	128	100
Total	94	47	106	53	200	100
P value	<0.0001					

CP RATIO	n	%
Normal	128	64
Abnormal	72	36
Total	200	100
Mean ± SD	1.57 ± 0.56	

The efficacy of employing gestational age-specific reference levels of CPRs in predicting adverse outcomes was compared by using a CPR value of less than 1.08. Mean CPR in the present study is 1.57 with a standard deviation 0.56.

Figure 11 PIE CHART SHOWING CP RATIO DISTRIBUTION



CEREBROPLACENTAL RATIO AND BIRTH WEIGHT:

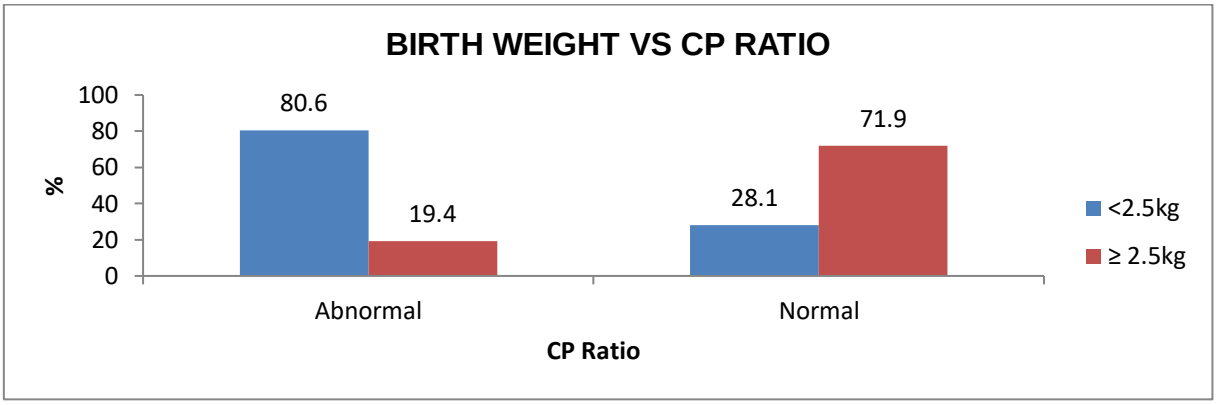
Table: 14. CORRELATION OF CP RATIO AND BIRTH WEIGHT

Table: 15. STATISTICAL ANALYSIS OF CP RATIO AND BIRTH WEIGHT

Sensitivity	61.70%
Specificity	86.79%
Positive predictive value	80.56%
Negative predictive value	71.88%
Accuracy rate	75%

Cerebroplacental ratio ≤ 1.08 has a sensitivity of 61.7% and specificity Of 86.79 % in predicting low birth weight <2.5kg which was statistically significant with a p value < 0.0001 and a diagnostic accuracy rate of 75%.

Figure: 12. ASSOCIATION OF CP RATIO AND BIRTH WEIGHT



CEREBROPLACENTAL RATIO AND APGAR:

Table: 16. CORRELATION BETWEEN CP RATIO AND APGAR

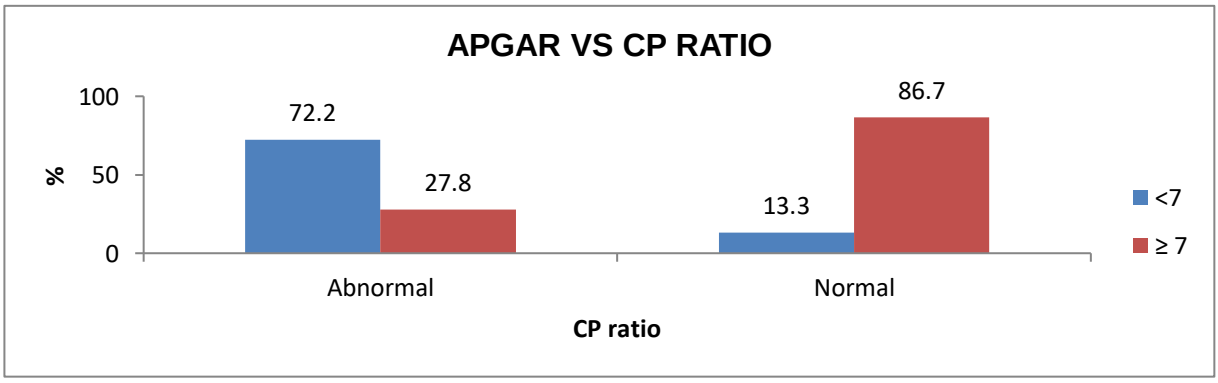
CPR	APGAR				Total	
	<7		≥ 7			
	N	%	n	%	N	%
Abnormal(<1.08)	52	72.2	20	27.8	72	100
Normal (≥1.08)	17	13.3	111	86.7	128	100
Total	69	34.5	131	65.5	200	100
P value	<0.0001					

Table: 17. STATISTICAL ANALYSIS OF CP RATIO AND APGAR

Sensitivity	75.36%
Specificity	84.73%
Positive predictive value	72.22%
Negative predictive value	86.72%
Accuracy rate	81.50%

Cerebroplacental ratio < 1.08 has a sensitivity of 75.36% and specificity of 84.73% in predicting APGAR <7 which was statistically significant with a p value < 0.0001 and a diagnostic accuracy rate of 81.50%

Figure: 13. ASSOCIATION OF CP RATIO AND APGAR



CEREBROPLACENTAL RATIO AND COLOR OF LIQUOR:

Table: 18. CORRELATION OF CP RATIO AND COLOUR OF LIQUOR

CPR	COLOUR OF LIQUOR				TOTAL	
	CLEAR		MSL			
	N	%	n	%	N	%

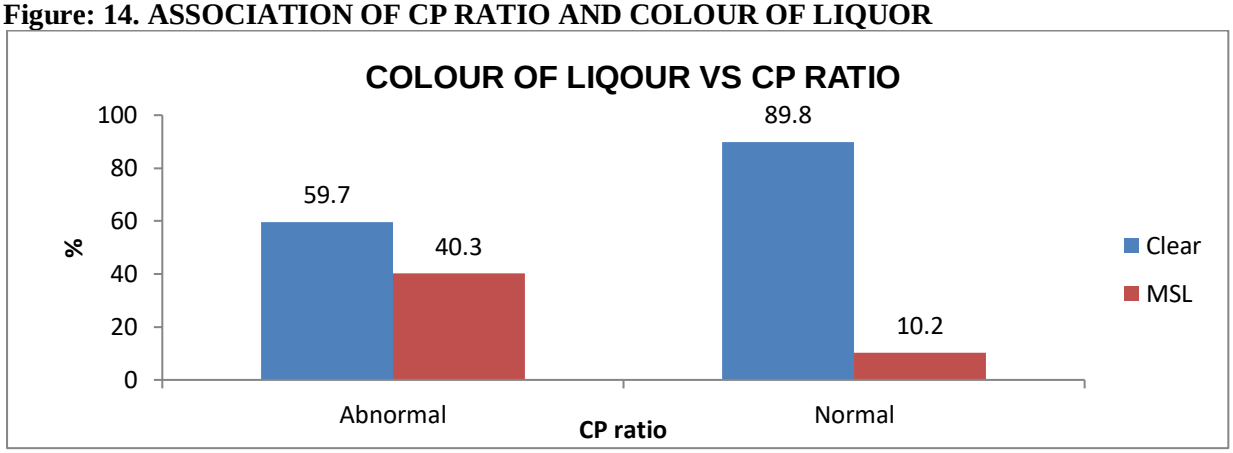
Abnormal(<1.08)	43	59.7	29	40.3	72	100
Normal (≥1.08)	115	89.8	13	10.2	128	100
Total	158	79	42	21	200	100
P value	<0.0001					

Table: 19. STATISTICAL ANALYSIS OF CP RATIO AND COLOUR OF LIQUOR

Sensitivity	27.22%
Specificity	30.95%
Positive predictive value	79.00%
Negative predictive value	59.72%
Accuracy rate	28.00%

Cerebroplacental ratio < 1.08 has a very low accuracy rate of predicting colour of liquor with an accuracy rate of 28% and hence is not statistically significant.

Figure: 14. ASSOCIATION OF CP RATIO AND COLOUR OF LIQUOR



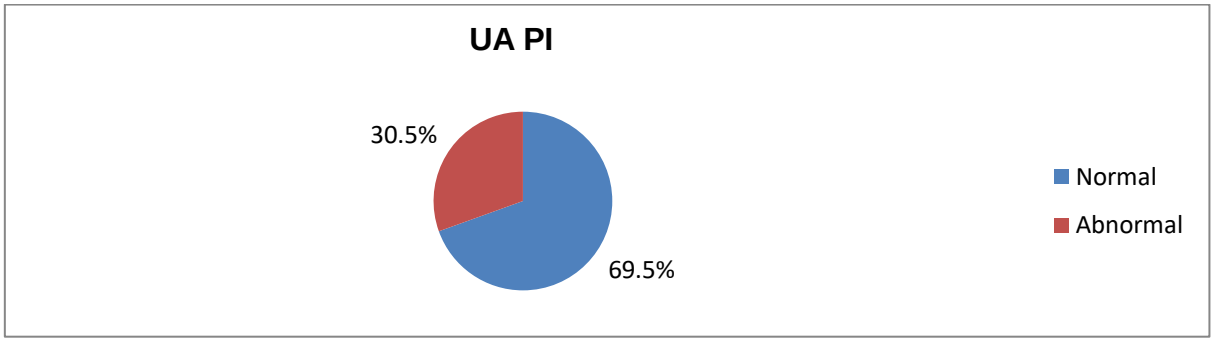
UA PI AND PERINATAL OUTCOME:

Table: 20. CORRELATION OF UA PI AND PERINATAL OUTCOME

UA PI	n	%
Normal	139	69.5
Abnormal	61	30.5
Total	200	100
Mean ± SD	1.01 ± 0.21	

UA PI value were considered based on gestational age specific reference values of which 69.5% individuals showed normal value and 30.5% showed values beyond 95th percentile which is considered abnormal for the corresponding gestational age. Mean UA PI in the present study is 1.01 with a standard deviation of 0.21

Figure: 15. DISTRIBUTION OF UA PI



UA PI AND BIRTH WEIGHT:

Table: 21. CORRELATION OF UA PI AND BIRTH WEIGHT

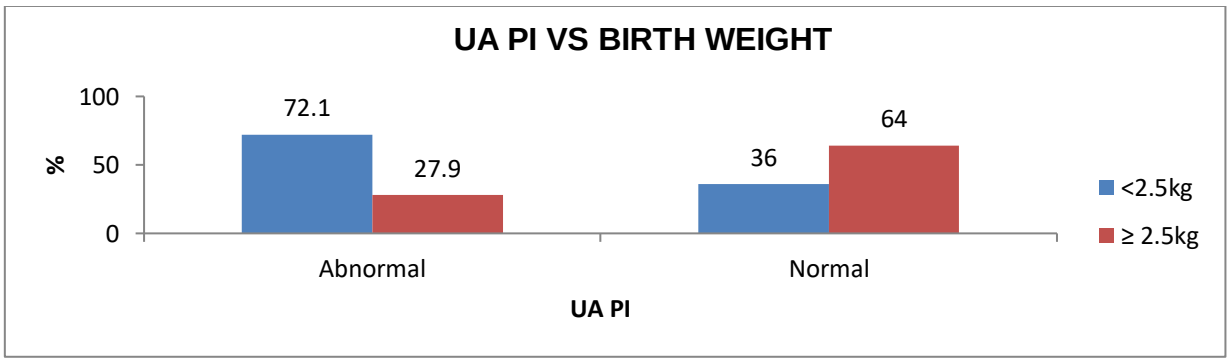
UA PI	BIRTH WEIGHT				TOTAL	
	<2.5kg		≥ 2.5kg			
	n	%	N	%	N	%
Abnormal	44	72.1	17	27.9	61	100
Normal	50	36	89	64	139	100
Total	94	47	106	53	200	100
P value	<0.0001					

Table: 22. STATISTICAL ANALYSIS OF UA PI AND BIRTH WEIGHT

Sensitivity	46.81%
Specificity	83.96%
Positive predictive value	72.13%
Negative predictive value	64.03%
Accuracy rate	66.50%

Abnormal UA PI value has a sensitivity of 46.81% in predicting low birth wt <2.5kg and specificity of >83.96% with a diagnostic accuracy rate of 66.50% for a p value<0.0001.

Figure 16 ASSOCIATION OF UA PI WITH BIRTH WEIGHT



UA PI AND APGAR:

Table: 23. CORRELATION BETWEEN UA PI AND APGAR

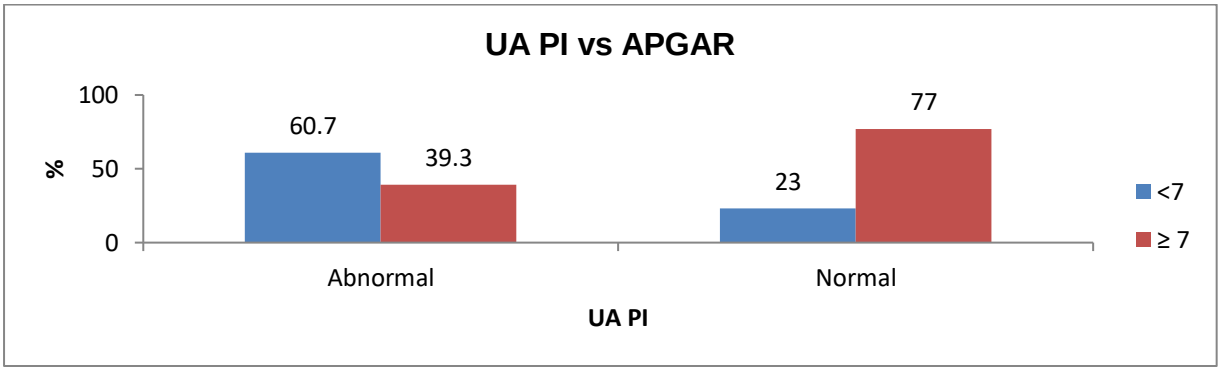
UA PI	APGAR				TOTAL	
	<7		≥ 7			
	N	%	N	%	N	%
Abnormal	37	60.7	24	39.3	61	100
Normal	32	23	107	77	139	100
Total	69	34.5	131	65.5	200	100
P value	<0.0001					

Table: 24. STATISTICAL ANALYSIS OF UA PI AND APGAR

Sensitivity	53.62%
Specificity	81.68%
Positive predictive value	60.66%
Negative predictive value	76.98%
Accuracy rate	72.00%

Abnormal UA PI value has a sensitivity of 53.62% and specificity of 81.68% in determining APGAR<7 with an accuracy rate of 72% for p value <0.0001.

Figure 17 ASSOCIATION OF UA PI WITH APGAR



UA PI AND COLOR OF LIQUOR:

Table: 25. CORRELATION OF UA PI AND COLOUR OF LIQUOR

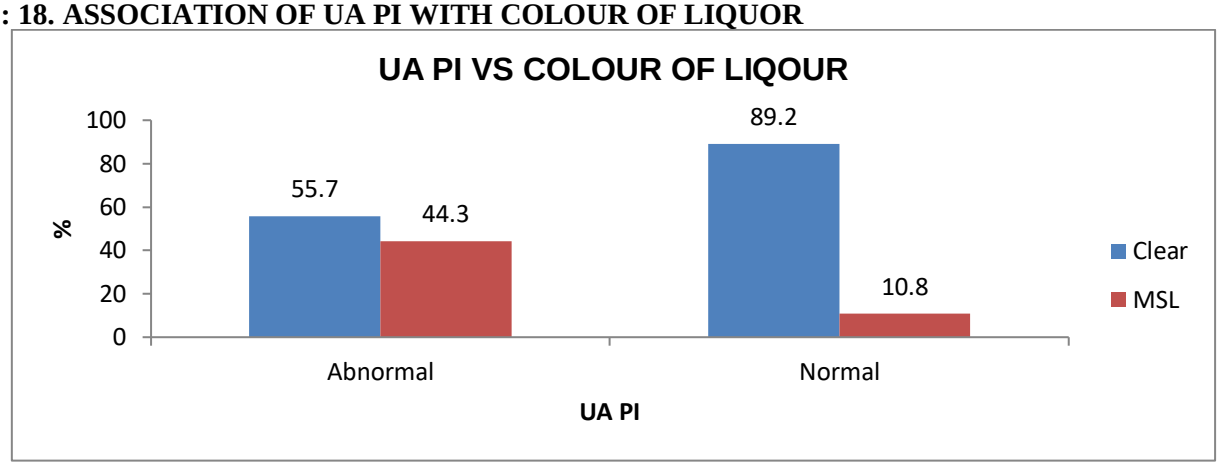
UA PI	COLOUR OF LIQUOR				TOTAL	
	CLEAR		MSL			
	n	%	N	%	N	%
Abnormal	34	55.7	27	44.3	61	100
Normal	124	89.2	15	10.8	139	100
Total	158	79	42	21	200	100
P value	<0.0001					

Table: 26. STATISTICAL ANALYSIS OF UA PI AND COLOUR OF LIQUOR

Sensitivity	21.52%
Specificity	35.71%
Positive predictive value	55.74%
Negative predictive value	10.79%
Accuracy rate	24.50%

Abnormal UA PI value has no significance in relation to color of liquor as sensitivity and specificity is 21.52% and 35.71% with very low positive and negative predictive values.

Figure: 18. ASSOCIATION OF UA PI WITH COLOUR OF LIQUOR



ADVERSE PERINATAL OUTCOME:

Table: 27. ADVERSE PERINATAL OUTCOME

	ADVERSE PERINATAL OUTCOME	%
Perinatal death	4	2%
Low APGAR	69	34.50%
NICU admissions	32	16%
Total	75	37.50%

Out of 200 cases, adverse perinatal outcome is seen in 75 cases which is 37.5% of the total cases. In the present study, low APGAR, NICU admissions and perinatal death were all seen cumulatively in some cases.

Table: 28. UA PI AND ADVERSE PERINATAL OUTCOME

UA PI	GOOD OUTCOME	ADVERSE PERINATAL OUTCOME	TOTAL	
			N	%
Abnormal	23	38	61	100
Normal	102	37	139	100
Total	125	75	200	100

Table: 29. STATISTICAL ANALYSIS OF UA PI AND ADVERSE PERINATAL OUTCOME

Sensitivity	50.66%
Specificity	81.66%
Positive predictive value	62.29%
Negative predictive value	73.38%
Accuracy rate	70%

Table: 30. CPR AND PERINATAL OUTCOME

CPR	GOOD OUTCOME	ADVERSE PERINATAL OUTCOME	TOTAL	
			N	%
Abnormal(<1.08)	19	53	72	100
Normal(≥1.08)	106	22	128	100
Total	125	75	200	100

Table: 31. STATISTICAL ANALYSIS OF CP RATIO AND ADVERSE PERINATAL OUTCOME

Sensitivity	70.66%
Specificity	84.8%
Positive predictive value	73.61%
Negative predictive value	82.8%
Accuracy rate	79.5%

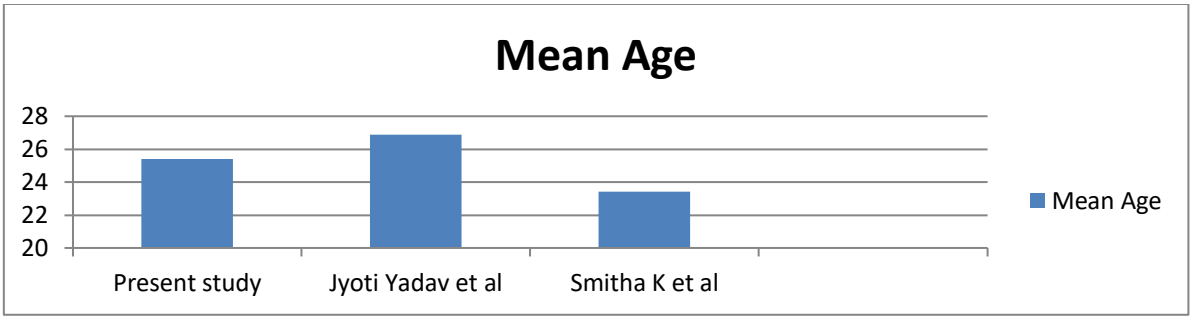
In the present study, for the 37.5% cases with adverse perinatal outcome, specificity of CP Ratio is 84.8% in predicting adverse perinatal outcome while that of UA PI is 81.6%. overall diagnostic accuracy rate is also high for CP ratio(79.5%) compared to UA PI alone (70%).

DISCUSSION:

COMPARISION WITH RESPECT TO AGE:

Out of 200 antenatal women included in the study 12 were below 19 yrs ,161 were between 20 – 29 yrs , 27 above 30 yrs. The mean age of the study group was 25.4years with a standard deviation of 3.48. The highest no.of cases were reported in the age group 20 – 29yrs.In a study conducted by Jyoti Yadav et al., 200 antenatal women with hypertensive disorder of pregnancy were recruited, maximum women 96 (48%) were within 25-30 yrs of age group and mean ± SD age was 26.9 ± 4.140yrs.[18] In a study conducted by Smitha k et al., out of 100 cases with PIH, 58% women were between the age group 21-25 yrs. The mean age in the study is 23.41yrs with a standard deviation of 3.1yrs. [19]

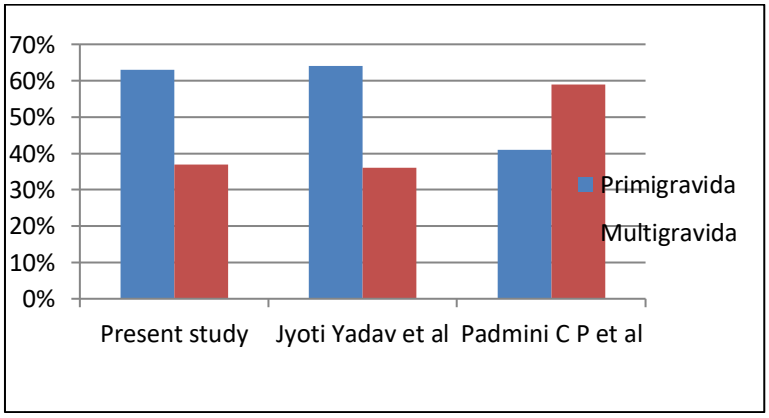
Figure: 19. COMPARISION OF MEAN AGE WITH OTHER STUDIES



COMPARISION BASED ON PARITY:

In the present study, 126 were primi gravida and 74 were multigravida. In the present study, hypertensive disorders are observed twice as common in primigravida compared to multigravida which is also seen in a study conducted by Andersch B et al. [18] In a study conducted by Jyoti Yadav et al., most of the women i.e., 128 out of 200 (64%) women were primigravida.[18] In a study by Padmini C P et al., 41%primigravida and 59% were multigravida.[20]

Figure: 20. COMPARISION BASED ON PARITY WITH VARIOUS STUDIES



COMPARISION BASED ON SEVERITY OF HTN:

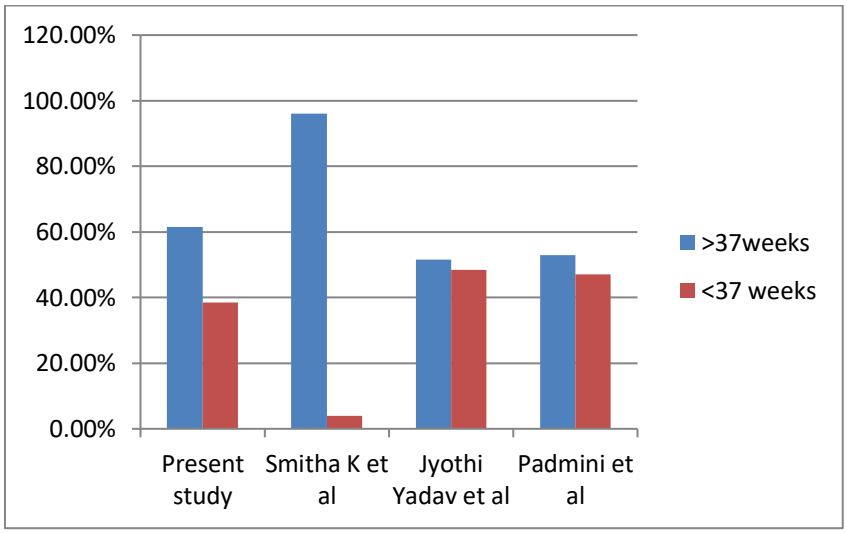
In the present study, out of 200 antenatal women, most of them had gestational hypertension 55%, followed by preeclampsia and eclampsia contributing to 40.5% and the remaining were chronic hypertensives and with superimposed preeclampsia. Smitha K et al., categorised the subjects into severe PIH and mild PIH which is 62% and 38% respectively.[19] Padmini C P et al categorised HTN into mild PIH and severe PIH which was 51.25% and 48.75% respectively.[20]

COMPARISION BASED ON GESTATIONAL AGE:

In the present study, the highest no of cases delivered beyond 37weeks of age. 12.5 % delivered between ≥32 – <34weeks, 26% delivered between ≥34-<37 weeks and 61.5% delivered at 37 weeks and later. The mean gestational age at delivery was 36.9 weeks with a

standard deviation of 2.24. In a study conducted by Smitha k et al., 96% women delivered before 37 weeks and 4% delivered beyond 37weeks.[19] In a study conducted by Jyoti Yadav et al., mean gestational age at delivery was 34.2±1.95 weeks in women with abnormal Doppler while it was 37.46±1.28 weeks in normal Doppler group. 37.5% in study group were late preterm delivery and 28% delivered <34 weeks while in control group 28% delivered were late preterm and only 11% delivered before 34 weeks. [18] In a study conducted by Padmini c.p et al, 52.9% showed gestational age >37weeks, 40% were between 33-37weeks gestation and 7.1% <32 weeks gestation.[20]

Figure: 21. COMPARISION BASED ON GEST AGE WITH VARIOUS STUDIES



COMPARISION BASED ON MODE OF DELIVERY:

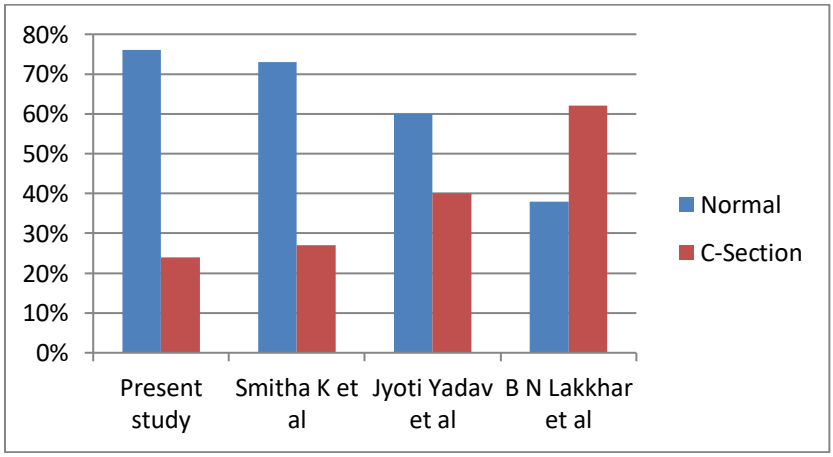
After routine investigations and follow up of the patient with serial ultrasound and Doppler, induction was planned based on the severity of the hypertension. Abnormal CP ratio was found in 72 women, and induction was planned in 48 cases of which 33 women delivered by vaginally with 15 women requiring Emergency LSCS for failed induction.

33 women required LSCS for indications causing foetal distress, meconium stained liquor, abnormal Doppler indices.

In the study by Smitha K et al., 73% delivered vaginally and 27% delivered by c-section.[19] In a study conducted by Jyoti Yadav et al., 60% delivered vaginally and 40% delivered by c section. It was found that 52.77% women in abnormal doppler group delivered by caesarean where as caeseran rate in normal Doppler group was 33%.[18]

In a study conducted by Bn Lakkhar et al., 37.9% delivered vaginally and 62.06% delivered by c-section.[21]

Figure 22 COMPARISION BASED ON MODE OF DELIVERY WITH VARIOUS STUDIES



COMPARISION BASED ON BIRTH WEIGHT:

In the present study, out of 200 babies,106 babies weighed more than 2.5kg (53%), 86 babies weighed between 1.5 – 2.4 and 8 babies weighed ≤ 1.5kg. The mean birth weight was 2.46kg with a standard deviation of 0.45kg. In a study conducted by S.Kanmani et al., mean birthweight was 1.9 kg with a standard deviation of 0.44.[22] In a study conducted by Smitha k et al., 36% babies are >2.5kg and 64% <2.5kg. UA-PI is significantly related to the low Birth weight with P<0.0001 in their study.[19]

COMPARISION OF ADVERSE PERINATAL OUTCOME:

In our study incidence of perinatal death, NICU admission and low APGAR score at 5 min were the criteria for adverse perinatal outcome. Out of 200 cases, adverse perinatal outcome is seen in 75 cases which is 37.5% of the total cases. In the present study, low APGAR, NICU admissions and perinatal death were all seen cumulatively in some cases (n=3). Pregnancy outcome was abnormal in 75 patients. More than one adverse outcome observed in some cases (n=26). In the study by Smitha k et al, variables that are considered for adverse perinatal outcome was Low APGAR, NICU admission, Caesarean section, IUD, Perinatal death. Pregnancy outcome was abnormal in 46 patients. More than one adverse outcome observed in some cases (n=23).[19] The present study demonstrates the cerebroplacental ratio and UA PI efficacy for determining the immediate perinatal outcome. Several studies conducted by Gramellini et al, Berkowitz et al and Fairlie et al have demonstrated the correlation between abnormal Doppler indices of fetal vessels and adverse perinatal outcome and fetal distress.[23-25]

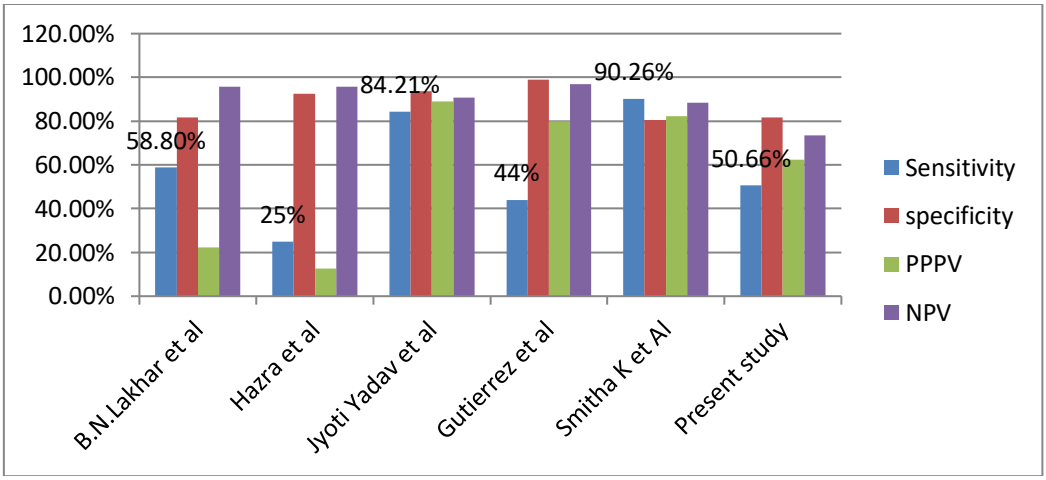
COMPARISION OF UA PI AND PERINATAL OUTCOME WITH OTHER STUDIES:

In the present study we studied umbilical artery PI and MCA/UA PI ratio, a Doppler index that reflects both umbilical-placental and cerebral vascular beds for identifying adverse perinatal outcome. Out of the two, Cerebroplacental ratio(MCA PI/UA PI) serves to be a better predictor compared to UA PI for determining adverse perinatal outcome. In the present study, UA PI value were considered based on gestational age specific reference values of which 69.5% individuals showed normal value and 30.5% showed values beyond 95th percentile which is considered abnormal for the corresponding gestational age. UA PI has better predictability at 32 weeks gestation in the present study. Mean UA PI in the present study is 1.01 with a standard deviation of 0.21. Abnormal UA PI value has a sensitivity of 46.81% in predicting low birth wt <2.5kg and specificity of >83.96% with a diagnostic accuracy rate of 66.50% for a p value<0.0001. Abnormal UA PI value has a sensitivity of 53.62% and specificity of 81.68% in determining APGAR<7 with an accuracy rate of 72% for p value <0.0001. In this study. the UA PI has a sensitivity of 50.66% and specificity of 81.6% in predicting adverse neonatal outcome. It has a PPV of 62.29% and NPV of 73.38%. Smitha et al., studied umbilical artery PI, middle cerebral artery PI and MCA/UA PI ratio. Out of 100 cases studied, 54 cases had abnormal UA PI and 46 cases had normal UA PI. 50 cases out of 54 had low birth weight which is 92.60% of the total abnormal UA PI Doppler. UA PI has a sensitivity of 90.26%, specificity of 80.57% and accuracy of 84% on predicting adverse pregnancy outcome.[19]Padmini C P et al studied on 80cases of which abnormal UA PI is seen in 93% cases and showed adverse perinatal outcome which proved to be more sensitive in their study compared to other UA Doppler indices.[18] Jyoti Yadav et al. found that UA PI had highest predictive power with sensitivity (84.21%), specificity(93.54%), PPV (88.88%) and accuracy (90%) followed by UA S/D having sensitivity (80.64%), PPV (76.92%) and accuracy (86.5%). Specificity and negative predictive power was same for all the UA indices.[18]Yoon BH et al demonstrated that an abnormal umbilical artery Doppler waveform is a strong and independent predictor of adverse perinatal outcome in patients with preeclampsia.[26] Present study is comparable with that of Jyoti Yadav et al, B.N. Lakhar et al), Hazra et al and Gutierrez et al where their studies also showed UA PI has more specificity than sensitivity.[18,21,27,28]But it is not comparable with the study of Smitha K et al as their study showed sensitivity of UA PI is more than specificity.[19]

Table: 32. COMPARISION OF UA PI WITH VARIOUS STUDIES

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
B.N. Lakhar et al[21]	58.80%	81.80%	22.20%	95.70%
Hazra et al[27]	25%	92.60%	12.50%	95.60%
Jyoti yadav et al[18]	84.21%	93.54%	88.88%	90.62%
Gutierrez et al [28]	44.00%	99.00%	80.00%	97.00%
Smitha K et al[19]	90.26%	80.57%	82.24%	88.35%
PRESENT STUDY	50.66%	81.60%	62.29%	73.38%

Figure: 23. COMPARISION OF STATISTICAL DATA OF UA PI WITH OTHER STUDIES



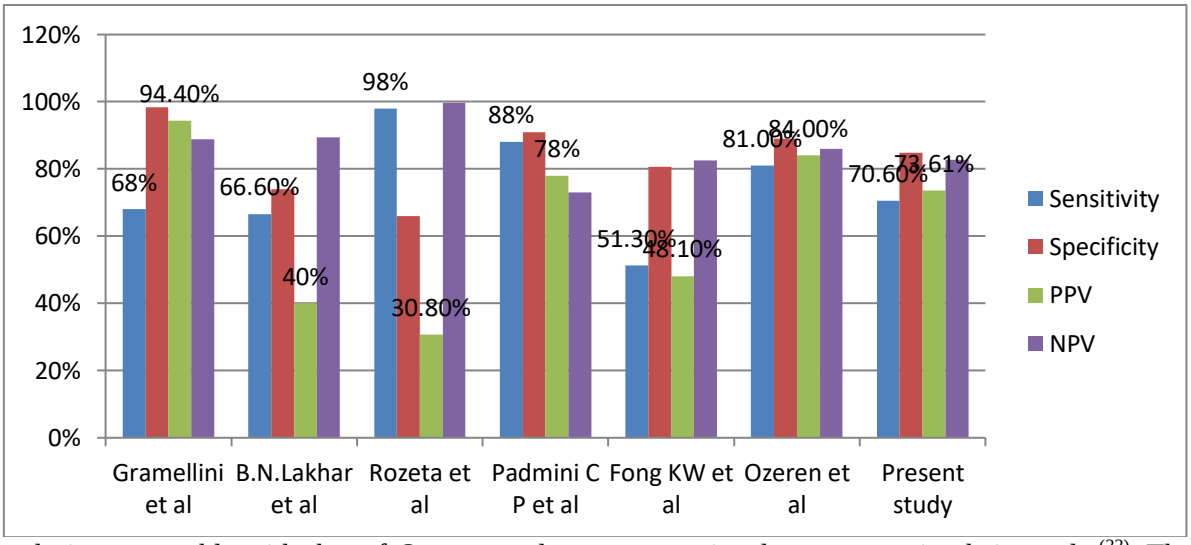
COMPARISION OF CP RATIO AND PERINATAL OUTCOME WITH OTHER STUDIES:

In the present study, cerebroplacental ratio has a better prediction for low birth weight, APGAR<7, NICU admissions and perinatal death compared to UA PI with a better sensitivity, specificity, positive and negative predictive values. But CP ratio and UA PI has no significant association with colour of liquor. Cerebroplacental ratio < 1.08 has a sensitivity of 61.7% and specificity of 86.79 % in predicting low birth weight <2.5kg which was statistically significant with a p value < 0.0001. Abnormal UA PI value has a sensitivity of 46.81% in predicting low birth wt <2.5kg and specificity of >83.96% with a diagnostic accuracy rate of 66.50% for a p value<0.0001. Cerebroplacental ratio < 1.08 has a sensitivity of 75.36% and specificity of 84.73% in predicting APGAR <7 which was statistically significant with a p value < 0.0001. Abnormal UA PI value has a sensitivity of 53.62% and specificity of 81.68% in determining APGAR<7 with an accuracy rate of 72% for p value <0.0001.Cerebroplacental ratio < 1.08 has a very good specificity of 84.8%, sensitivity of 70.6%, PPV of 73.61%, NPV of 82.8% in predicting adverse perinatal outcome. It has a better diagnostic accuracy rate of 79.50% when compared with UA PI alone. Cerebroplacental ratio < 1.08 has a very low accuracy rate of predicting colour of liquor with an accuracy rate of 28%. Abnormal UA PI value has no significance in relation to colour of liquor as sensitivity and specificity is 21.52% and 35.71% respectively with very low positive and negative predictive values. Wladimiroff et al reported that CP ratio does not vary significantly between 30 and 40 weeks of gestation Hence it is possible to use a single cut off value for CP ratio after 30 weeks. [29] Arbeille et al also found CP ratio to be constant during last 10 weeks of gestation and suggested a cut off value of 1.08 above which values are considered normal and below 1.08 values are abnormal.[10]Mari G et al, have suggested that cerebral Doppler indices are associated with adverse perinatal outcome, while others like Gramellini et al and Ozeren M et al have proposed the cerebral-umbilical ratio as a better predictor of adverse perinatal outcome.[23,30,31]

Table: 33. COMPARISION OF CP RATIO WITH VARIOUS STUDIES

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Gramellini et al[23]	68%	98.40%	94.40%	88.80%
B.N.Lakhar et al[21]	66.60%	73.90%	40%	89.40%
Rozeta et al[32]	98%	66%	30.80%	99.70%
Padmini C P et al[20]	88%	91%	78%	73%
Fong KW et al[33]	51.30%	80.60%	48.10%	82.50%
Ozeren et al[30]	81.00%	89.00%	84.00%	86.00%
PRESENT STUDY	70.60%	84.80%	73.61%	82.80%

Figure: 24. STATISTICAL DATA OF CP RATIO WITH OTHER STUDIES



Present study is comparable with that of Ozeren et al and Gramellini et al who also concluded that CP ratio had higher sensitivity and positive predictive value compared to UA PI.[23,30]Present study is not correlating with Fong KW et al who showed a sensitivity and PPV of 51.3% and 48.1% respectively, the difference may be because they included small for gestational age cases in their study.[33] The present study also doesn't correlate with that of Rozeta et al where their study showed higher sensitivity of CP ratio compared to specificity which is not as that of the present study. But the study correlates with respect to their high NPV(99.70%) which is similar to the present study where the NPV is 82.8%.

COMPARISION OF DIAGNOSTIC ACCURACY:

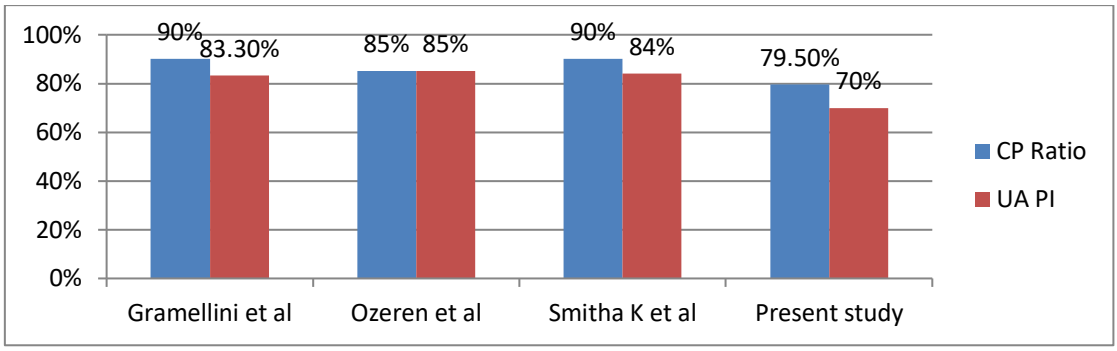
Our study shows highest diagnostic accuracy for CP ratio, followed by umbilical artery pulsatility index.

Table: 34. COMPARISION OF DIAGNOSTIC ACCURACY WITH VARIOUS STUDIES

	CP Ratio	UA PI
Gramellini et al[23]	90.00%	83.30%
Ozeren et al[30]	85.00%	85.00%
Smitha K et al[19]	90.00%	84.00%
PRESENT STUDY	79.50%	70%

The present study is comparable with Gramellini et al and Smitha et al in terms of diagnostic accuracy where cerebroplacnetal ratio has been proved to have been better predictor compared to UA PI alone. [19,23] Present study is not correlating with Ozeren et al where the diagnostic accuracy is same for both cerebroplacental ratio and UA PI.[30]

Figure: 25. ANALYSIS OF DIAGNOSTIC ACCURACY OF CP RATIO AND UA PI WITH VARIOUS STUDIES



CONCLUSION:

The present study draws inference that hypertensive disorders of pregnancy are most common in Primigravida and the mean age group is 25.4yrs with a standard deviation of 3.48.The study states that cerebroplacental ratio is a better tool for assessing immediate perinatal outcome. It has good accuracy for determining low birth weight and APGAR <7.UA PI also has a better accuracy for determining immediate perinatal outcome but out of comparision, Cerebroplacental ratio seems to be a better predictor in the present study. Overall diagnostic accuracy for the present study is 79.5% for CP Ratio and 70% for UA PI.Doppler velocimetry which is a non invasive tool has proved to detect early foetal compromise and in hypertensive disorders of pregnancy. It also aids in planning a timely delivery and thereby reducing both perinatal morbidity as well as perinatal mortality.Compared to other methods of foetal monitoring, the use of Doppler has proved to be more sensitive in detecting foetal compromises early and helps in aiding appropriate and timely delivery.

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