

Original Research Article

A Study on Doppler of Fetal Umbilical and Middle Cerebral Artery in Preeclampsia with Fetal Growth Restriction and Its Correlation with Perinatal Outcome- In Tertiary Care Hospital, Kadapa

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Abstract

Preeclampsia is a pregnancy complication characterized by high blood pressure and signs of damage to another organ systems. Early detection of preeclampsia may allow vigilant antenatal surveillance and appropriate timing of fetal delivery to avoid serious sequelae. Doppler ultrasound study helps in detecting the extent of placental pathology and predicting the perinatal outcome. The aim is to study S/D ratio, Resistance Index, Pulsatility Index, Cerebro Placental Ratio and correlate perinatal outcome to Doppler Umbilical and Middle cerebral artery waveforms in Preeclampsia with FGR. This prospective observational study performed for a period of one and half year and a total of 100 Patients with 28- 40 weeks gestational age was undergone for Doppler waveform analysis of both umbilical artery and the middle cerebral artery. Out of 100 patients, 15 patients had AEDF and 4 patients had REDF; hence S/D ratio could not be calculated in them. Amongst the 81 patients, 38 patients (47%) had a normal umbilical artery S/D ratio (<3) while 43 patients (53%) had elevated S/D ratio (>3). Umbilical artery RI ratio 55 patients (55%) had elevated RI, and 45 patients (45%) had normal RI, umbilical artery PI values showed 57 patients (57%) with elevated PI values and 43 patients (43%) showed normal PI values. MCA S/D ratio analysis showed that was decreased in 56 patients (56%) and normal in 44 patients (44%). MCA RI showed 44 patients (44%) had decreased RI and the remaining 56 patients (56%) had normal values. MCA PI analysis showed that 41 patients (44%) had decreased RI and the remaining 59 patients (56%) had normal values. CPR analysis showed that 51 patients (44%) had decreased RI and the remaining 49 patients (56%) had normal values and showed that abnormal Doppler waveforms were associated with adverse perinatal outcome.

Keywords: Doppler Study, Perinatal outcome, Umbilical cord, Preeclampsia, Pregnancy.

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Introduction

Hypertensive disorders are the most common medical complications during pregnancy, leading to the majority of the adverse perinatal and maternal outcome[1]. Preeclampsia accounts for 7-10% of perinatal mortality in developed countries and 20% in developing countries. Early detection of preeclampsia may allow vigilant antenatal surveillance and appropriate timing of fetal delivery to avoid serious sequelae[2]. Pre-eclampsia and Fetal Growth Restriction are two conditions that are felt to be the result of abnormal placenta formation involving the defective trophoblastic invasion of spiral arteries and a reduction in the vascular resistance in the uteroplacental circulation[3,4]. The decreased uteroplacental perfusion may result in fetal growth restriction, thereby reduced amniotic fluid volume and an inability to withstand the inutero environment leading to intrauterine death[5]. The timely diagnosis of fetal compromise is essential to conduct delivery, can be conducted before fetus suffers irreversible changes, thereby damage and in utero death can be prevented. Doppler sonography of Fetal Umbilical artery and Middle Cerebral Artery provides a unique tool for the evaluation of physiological and hemodynamic fetoplacental blood flow information. Doppler study does correlate well with fetal

compromise giving earlier warning sign of fetal distress than other tests[6].

Aims of the Study

- ✓ To study S/D ratio, Resistance Index, Pulsatility Index and the Cerebro Placental Ratio of the Fetal Umbilical artery and Middle Cerebral Artery in Preeclampsia with FGR.
- ✓ To correlate perinatal outcome to Doppler Umbilical and Middle cerebral artery waveforms in Preeclampsia with FGR.

Materials and Methods

This hospital-based prospective descriptive observational study performed for a period of one and half year from January 2019 to June 2020 in OBG department at Government Medical College, Kadapa (Dt), Andhra Pradesh. This study got ethical approval from the IEC of GGH, Kadapa. A total of 100 Patients admitted during study period with singleton live pregnancies with vertex presentation between 28-40 weeks complicated with preeclampsia with FGR were included after obtaining informed consent. Doppler waveform analysis of both umbilical artery and the middle cerebral artery was performed. Colour Duplex Doppler was used to identify the umbilical cord by identifying the free-floating loop. The angle of insonation was then utilized optimally and the signals obtained. Umbilical artery S/D ratio was considered abnormal when it was more than 3. Umbilical artery RI and PI were assessed to be elevated when more than 95th percentile. MCA is the largest terminal branch of the internal carotid artery and was insonated at the level of the greater wing of sphenoid. The angle of insonation can easily be kept at 0 for this vessel. Systolic flow (A) and the diastolic flow (B) for the above-mentioned arteries were obtained. The management of the

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cases i.e., Pregnancies were terminated according to the clinical status and Doppler changes.

Results

A total of 100 patients were categorized based on age groups and others as follows majority of the patients, 56 (56 %) were in between the age group of 21-25, 29 (29 %) in between the age group of 26-30, Very fewer patients in between the age group of < 20 (11%) and 30-35 (04%). Based on parity 61 patients (61%) were primigravida and

39 patients (39%) were multigravida. The mean gestational age group 37 – 40 weeks included.

Umbilical artery Doppler indices

Among 100 patients studied, 15 patients had AEDF, and 4 patients had REDF; hence S/D ratio could not be calculated in them. Amongst the remaining 81 patients, 38 patients (47%) had a normal umbilical artery S/D ratio (<3) while 43 patients (53%) had elevated S/D ratio (>3).

Umbilical artery S/D ratio correlation with the perinatal outcome

Table 1: Umbilical artery S/D ratio correlation with perinatal outcome

Perinatal outcome	Increase in S/D ratio		Normal S/D ratio		P-Value	Sensitivity	Specificity
	N=43	%	N=38	%			
LSCS for fetal distress	28	65.1	5	13.2	< .05	72.22%	52.38%
Meconium stained liquor	22	51.1	5	13.2	< .05	81.48%	61.11%
APGAR<7(5 min)	23	53.5	2	5.2	< .05	92.00%	64.29%
NICU Admission	29	67.4	6	15.7	< .05	82.86%	69.57%
NICU stay>48hrs	20	46.5	2	5.2	< .05	90.91%	61.02%
Perinatal Mortality	1	2.3	-	-	-	-	-

All data showed statistical significance (<.05), and UA S/D had a sensitivity of 92% in determining APGAR < 7 at 5min, and a specificity of 69.57% in determining NICU admissions. Umbilical artery RI ratio analysis showed that 55 patients (55%) had elevated RI, and 45 patients (45%) had normal RI.

Umbilical RI values correlation with perinatal outcome

Table 2: Umbilical artery RI values correlation with perinatal outcome

Perinatal outcome	Elevated RI		Normal RI		P-Value	Sensitivity	Specificity
	N=55	%	N=45	%			
LSCS for fetal distress	16	29.1	2	4.4	< .05	88.89%	52.44%
Meconium stained liquor	27	49.1	5	11.1	< .05	84.38%	58.82%
APGAR<7(5 min)	28	50.9	0	-	-	100.00%	62.50%
NICU Admission	37	67.2	5	11.1	< .05	88.10%	68.97%
NICU stay>48hrs	20	36.3	2	4.4	< .05	90.91%	55.13%
Perinatal Mortality	12	21.8	0	-	-	100.00%	51.14%

All data showed statistical significance (<.05), and UA RI had a sensitivity of 100% in determining APGAR < 7 at 5min, and a specificity of 68.97% in determining NICU admissions.

Analysis of umbilical artery PI values showed 57 patients (57%) with elevated PI values and 43 patients (43%) showed normal PI values.

Umbilical PI correlation with perinatal outcome

Table 3: Umbilical PI correlation with perinatal outcome

Perinatal outcome	Elevated PI		Normal PI		P-Value	Sensitivity	Specificity
	N=57	%	N=43	%			
LSCS for fetal distress	17	29.8	2	6.5	< .05	89.47%	50.62%
Meconium stained liquor	28	49.1	5	11.6	< .05	84.85%	56.72%
APGAR<7(5 min)	28	49.1	0	-	-	100.00%	59.72%
NICU Admission	39	68.4	6	13.9	< .05	86.67%	67.27%
NICU stay>48hrs	24	42.1	3	6.9	< .05	88.89%	54.79%
Perinatal Mortality	12	21.1	-	-	-	-	-

Out of the 100 patients studied 15 patients had AEDF, and 4 patients had REDF.

Middle cerebral artery Doppler indices

MCA S/D ratio analysis showed that was decreased in 56 patients (56%) and normal in 44 patients (44%).

MCA S/D ratio correlation with perinatal outcome

Table 4: MCA S/D ratio correlation with perinatal outcome

Fetal outcome	Abnormal S/D		Normal S/D		P-Value	Sensitivity	Specificity
	N=56	%	N=44	%			
LSCS for fetal distress	13	23.21	3	6.81	< .05	81.25%	48.81%
Meconium stained liquor	23	41.07	5	11.36	< .05	82.14%	54.17%
APGAR<7(5 min)	25	50.00	2	4.54	< .05	92.59%	57.53%
NICU Admission	30	53.57	5	11.36	< .05	85.71%	60.00%
NICU stay>48hrs	22	39.28	1	2.27	< .05	95.65%	55.84%
Perinatal Mortality	12	21.42	-	-	-	-	-

All data showed statistical significance (<.05), and MCA S/D ratio had a sensitivity of 95.65% in determining the NICU stay>48hrs and a specificity of 60% in determining NICU admissions. MCA RI analysis showed that 44 patients (44%) had decreased RI and the remaining 56 patients (56%) had normal values.

MCA RI correlation with perinatal outcome

Table 5: MCA RI correlation with perinatal outcome

Fetal outcome	Abnormal RI		Normal RI		P-Value	Sensitivity	Specificity
	N=44	%	N=56	%			

LSCS for fetal distress	11	25.00	4	7.14	< .05	73.33%	61.18%
Meconium stained liquor	19	43.18	5	8.92	< .05	79.17%	67.11%
APGAR<7(5 min)	21	47.72	1	1.78	< .05	95.45%	70.51%
NICU Admission	27	61.36	3	5.35	< .05	90.00%	75.71%
NICU stay>48hrs	19	43.18	1	1.78	< .05	95.00%	68.75%
Perinatal Mortality	12	27.27	0			100.00%	63.64%

MCA RI had the highest sensitivity (95%) for NICU stay >48hrs and highest specificity for predicting NICU admissions (75.71%) and 100% sensitivity in predicting perinatal mortality.

MCA PI value correlation with perinatal outcome

Table 6: MCA PI correlation with perinatal outcome

Perinatal outcome	Abnormal PI		Normal PI		P-Value	Sensitivity	Specificity
	N=41	%	N=59	%			
LSCS for fetal distress	11	26.82	5	8.47	< .05	68.75%	64.29%
Meconium stained liquor	18	43.90	6	10.16	< .05	75.00%	69.74%
APGAR<7 (5 min)	22	53.65	1	1.69	< .05	95.65%	75.32%
NICUAdmission	28	68.29	3	5.08	< .05	90.32%	81.16%
NICU stay>48hrs	19	46.34	1	1.69	< .05	95.00%	72.50%
Perinatal Mortality	12	29.26	0			100.00%	67.05%

All data except two showed statistical significance (<.05), and MCA PI had a sensitivity of 95.65% in determining APGAR<7 at 5min and highest specificity of 81.17% in determining NICU admissions.

CPR correlation with perinatal outcome

Table 7: CPR correlation with perinatal outcome

Perinatal outcome	CPR <1		CPR > 1		P-Value	Sensitivity	Specificity
	N=51	%	N=49	%			
LSCS for fetal distress	28	54.90	5	10.20	< .05	77.27%	56.41%
Meconium stained liquor	27	52.94	5	10.20	< .05	84.38%	64.71%
APGAR<7(5 min)	28	54.90	0	-	-	100.00%	68.06%
NICUAdmission	37	72.54	5	10.20	< .05	88.10%	75.86%
NICU stay>48hrs	21	41.17	2	4.08	< .05	91.30%	61.04%
Perinatal Mortality	12	23.52	0	-	-	100.00%	55.68%

It is the ratio of PI of MCA to the PI of the umbilical artery. 51 cases out of 100 had a CPR <1 showing redistribution of blood flow ("BRAIN SPARING EFFECT"). A statistical correlation was drawn and found to be significant (p<.05) in all the parameters in predicting poor perinatal outcome. CPR had the highest sensitivity (100%) compared to all other indices.

Discussion

Doppler ultrasound study helps in detecting the extent of placental pathology and predicting the perinatal outcome. The present study showed that abnormal Doppler waveforms were associated with adverse perinatal outcome.

In the present study, umbilical artery S/D analysis showed that 65.11% patients underwent LSCS for fetal distress, APGAR score <7 at 5min was seen in 53.5%, NICU admission was seen in 67.4% babies and perinatal mortality was 2.3%. Singh and Mishra⁷ study showed that 19% patients underwent LSCS for fetal distress, APGAR<7 at 5min was seen in 53.5% patients, NICU admission was needed for 78.7% babies and perinatal mortality was seen in 7% babies. Shenoy et al⁸ study showed that 75.6% patients underwent LSCS for fetal distress in 75.6% and NICU admission was needed for 92.5% babies. Patel CK et al⁹ study showed that NICU admission was needed for 64% of babies and perinatal mortality was seen in 28% babies. Correlation of Abnormal UA S/D ratio analysis with perinatal outcome in the Present study is comparable to that of Patel CK et al[9] in patients who underwent LSCS for fetal distress(65%), APGAR<7 at 5min (51%) and NICU admission (64%) although it varied in perinatal mortality(28%). When umbilical artery RI value was correlated to fetal outcome in the present study, it was shown that there was an increase in the perinatal morbidity and mortality in cases with an abnormal umbilical artery RI value. When umbilical artery RI values were compared with other studies it showed that 29.1% cases underwent LSCS for fetal distress which is similar to that of Patel CK et al[9] study (30%), whereas it is more in Singh and Mishra[7] (68%) and Shenoy et al[8] (45.65%) studies. In the present

study, NICU admission was required for 67.2% babies whereas Singh and Mishra[7], Patel CK et al and Shenoy et al reported 56%, 55%, 45.65% respectively. Perinatal mortality in the present study was 21.8% whereas it was 18% and 19% in Singh and Mishra[7] and Patel CK et al[9] studies respectively and it varied from Shenoy et al which was 6.52%. Hence, abnormal UA RI with perinatal outcome in the present study showed good correlation with Patel CK et al in LSCS for fetal distress and perinatal mortality although it varied from Shenoy et al in perinatal mortality. When umbilical artery PI value was correlated to fetal outcome in the present study, it was shown that there was an increase in the perinatal morbidity and mortality in cases with an abnormal umbilical artery PI value. In the present study, 29.8% cases with abnormal UA PI underwent LSCS for fetal distress whereas Singh and Mishra[7], Shenoy et al[8] and Patel CK et al[9] reported 48%, 40% and 38% cases respectively. When meconium stained liquor with abnormal UA PI is compared with other studies, present study reported 67.2% which is correlating with other studies. Perinatal mortality is highest in Patel CK et al study group seen in 28% babies whereas in the present study it is 21.8%. Hence, perinatal mortality (22%) in the present study with abnormal UA PI is better comparable to that of Singh and Mishra study[7]. When our study was compared with Singh and Mishra et al study in assessing the sensitivity of various fetal outcomes among abnormal MCA S/D values it showed good correlation except in LSCS for fetal distress. In the present study, sensitivity of MCA S/D ratio analysis for LSCS for fetal distress 81.25%, Meconium stained liquor is 82.14%, APGAR score<7 at 5min is 92.59%, NICU admission is 85.71% and 95.65% for the babies requiring NICU stay for >48hours. Similar results were obtained for LSCS for fetal distress in Hindumathi et al and Shenoy et al[8] studies showing 74.8% and 76.4% respectively whereas Singh and Mishra[7] study reported only 25.86%. Singh and Mishra[7], Shenoy et al[8] and Hindumathi et al studies reported 78.3%, 76.4%, 77.6% respectively [10] for meconium stained liquor which is similar to the present

study. APGAR Score <7 at 5min also showed similar sensitivity results with the present study which reported 93.9%, 88.4%, 90.4% in Singh and Mishra, Shenoy et al and Hindumathi et al[10] respectively. Singh and Mishra, Shenoy et al and Hindumathi et al reported that sensitivity for NICU admission was 83%, 88.4%, 84.2% which is similar to the present study. When NICU stay >48 hours was compared with the other studies, present study reported 95.65%, similar sensitivity results were reported in Singh and Mishra, Shenoy et al and Hindumathi et al studies which was 96.8%, 94.6%, 92.6% respectively. Hence, sensitivity of present study with abnormal MCA S/D ratio for LSCS for fetal distress and meconium stained liquor which is comparable to Shenoy et al and Hindumathi et al studies. When sensitivity of MCA RI values correlation with perinatal outcome is compared with other studies, it showed that Hindumathi et al study reported highest sensitivity of 75.4% which is comparable to the present study (73.33%) in patients who underwent LSCS for fetal distress. Sensitivity for Meconium stained liquor with abnormal MCA RI is highest in the present study (79.17%) followed by Shenoy et al (76.4%) and Hindumathi et al (72.4%) studies whereas Singh and Mishra study is least sensitive (56.7%). When sensitivity of APGAR<7 at 5min is compared, present study is highly sensitive (95.45%) followed by Shenoy et al (91.4%) and Hindumathi et al[10] (88.6%) whereas Singh and Mishra[7] is least sensitive (69.6%). Sensitivity for NICU admission in the present study is the highest with 90% followed by Shenoy et al and Hindumathi et al[10] reporting 84.6.4% and 88.6% respectively. NICU stay >48 hours in the present study with abnormal MCA RI is 95% sensitive which is comparable to that of Shenoy et al study (92.4%). Hence, the present study with abnormal MCA RI is highly sensitive for meconium stained liquor, APGAR <7 at 5min, NICU admission, NICU stay >48 hours and comparable to that of Shenoy et al[8]. In the present study, low MCA PI was associated with 29.26% of perinatal mortality with a sensitivity of 100% and specificity of 67.05%. When compared to other studies, present study is highly sensitive (100%) followed by Rochelson et al[11] study (98%) whereas Singh and Mishra[7] study is less sensitive (17.3%). Hindumathi et al study is highly specific (85%) followed by the present study (67.05%) whereas Smitha et al[12] is least specific (52.38%). Our study is comparable to that of Rochelson et al[11] study although it varied from that of Singh et al study. In the present study, CPR<1 was seen in 54.9% patients who underwent LSCS for fetal distress and results were similar to Patel CK et al which was 64%. In Gramellini et al[13] and Varsha Deshmukh et al[14], LSCS for fetal distress with abnormal CPR was done for 88.8% and 86.7% cases. In the present study, APGAR<7 at 5min was seen in 54.9% cases similar to that of Patel CK et al study which was 48% and it differs from other studies, Gramellini et al and Varsha Deshmukh et al which reported APGAR<7 at 5min in 16% and 10.8% of the babies respectively. Present study with abnormal CPR reported NICU stay >48 hours in 41.1% babies whereas Gramellini et al[13], Varsha Deshmukh et al[14] and Patel CK et al reported NICU stay >48 hours in 77%, 70% and 64% of the babies respectively. CPR analysis correlation with perinatal outcome is comparable to Patel CK et al although it varied from other studies.

Conclusion

- ✓ The present study noted an adverse fetal outcome in cases of severe preeclampsia with FGR, which showed abnormal Doppler results.
- ✓ The finding of REDF is ominous with 100% perinatal mortality and AEDF also correlated with the poor fetal outcome with a perinatal mortality of 46.6%.
- ✓ In our study, CPR had the highest sensitivity of 100% in predicting adverse fetal outcomes.
- ✓ Because CPR incorporates data not only on the placental side but also the fetal response, hence it can be considered potentially more advantageous.

Conflict of Interest: Nil Source of support: Nil

- ✓ Doppler patterns follow a longitudinal trend with early changes in the umbilical artery, followed by the middle cerebral artery.
- ✓ Doppler investigation of the fetal circulation plays an important role in monitoring the redistributing circulation of the fetus and thereby may help to determine the optimal time for delivery.
- ✓ Doppler serves as an important yardstick for the obstetricians when dealing with pregnancies complicated with preeclampsia and growth restriction.

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