

## Cerebroplacental Ratio in Predicting Perinatal Outcome In Pregnant Females With Pre- Eclampsia

Ankur Gautam<sup>1</sup>, Shivani Parmar<sup>2</sup>, Ankita Sharma<sup>3</sup>

1. MD Radiodiagnosis, DR. RPGMC Tanda (H.P.)

2. MDS Prosthodontics and Crown & Bridge, HDC Sundernagar (H.P.)

3. Junior Resident, Pathology, IGMC Shimla (H.P.)

Corresponding Author: Shivani Parmar, MDS Prosthodontics and Crown & Bridge, HDC Sundernagar (H.P.)

Email id – shivaniprnr27@gmail.com

---

### Abstract

**Objective** – Current study aims at studying the cerebroplacental ratio in pregnant females with preeclampsia and its role in predicting perinatal outcome.

**Material and Methods** - This study included 93 pregnant females >28 weeks of gestation diagnosed of having pre-eclampsia in routine Obstetric and Gynecology OPD which were sent for fetal doppler. Doppler evaluation was carried out to measure the CPR. Pregnant females were followed for adverse perinatal outcome such as intrauterine death and neonatal death, cesarean delivery for fetal distress, admission to neonatal intensive care unit, Apgar score below 7 at 5 minutes and IUGR fetuses.

**Results** – Studied pregnant females were divided into two groups i.e. group I with CPR > 1 and group II with CPR < 1. Relation of these groups were studied with perinatal outcome. P value was less than 0.0001 which is statistically significant. In this study the sensitivity of CPR < 1 in predicting perinatal outcome was 45%, specificity was 95%, PPV was 83% and NPV was 76%.

**Conclusion** - CPR was found to be sensitive and specific in the prediction of poor neonatal outcome in pregnancies with preeclampsia. Hence it may help with patient counseling regarding adverse neonatal outcomes in cases of pre-eclampsia in third trimester.

---

Date of Submission: 20-05-2020

Date of Acceptance: 06-06-2020

---

### I. Introduction

Pre-eclampsia affects 5-10% of pregnancies and is clinically manifested after 20 weeks of gestation.<sup>1</sup> Vascular endothelial damage and vasospasm leading to defects in fetal hemodynamics plays the major role in the pathogenesis of preeclampsia.<sup>2</sup> Preeclampsia may lead to impaired uteroplacental blood flow causing some complications such as intrauterine growth restriction (IUGR), oligohydroamnios, placental abruption. In order to decrease the risk of these manifestations and prevent intrauterine fetal death, accurate timing for the delivery of the fetus should be done in the ante-partum evaluation of the preeclamptic pregnancies. Doppler ultrasound techniques have been used to follow and manage complicated pregnancies and there is strong evidence that abnormal Doppler ultrasound correlates with pregnancy complications.<sup>3</sup> The cerebroplacental ratio (CPR), the ratio of the pulsatility index (PI) of the Middle cerebral artery (MCA) to that of the Umbilical Artery (UA), can detect fetal hypoxemia occurring via two different mechanisms; reduced resistance in the MCA (brain sparing effect) and increasing placental resistance.<sup>4</sup> The CPR is considered to be a marker of centralization of fetal blood flow as an adaptation to placental insufficiency, such as that seen in preeclampsia.<sup>5,6</sup> The CPR has been hypothesized to be more accurate than its individual components.<sup>7</sup>

The purpose of this study was to calculate CPR in pregnancies with pre-eclampsia and to demonstrate its role in predicting perinatal outcome.

### II. Material And Methods

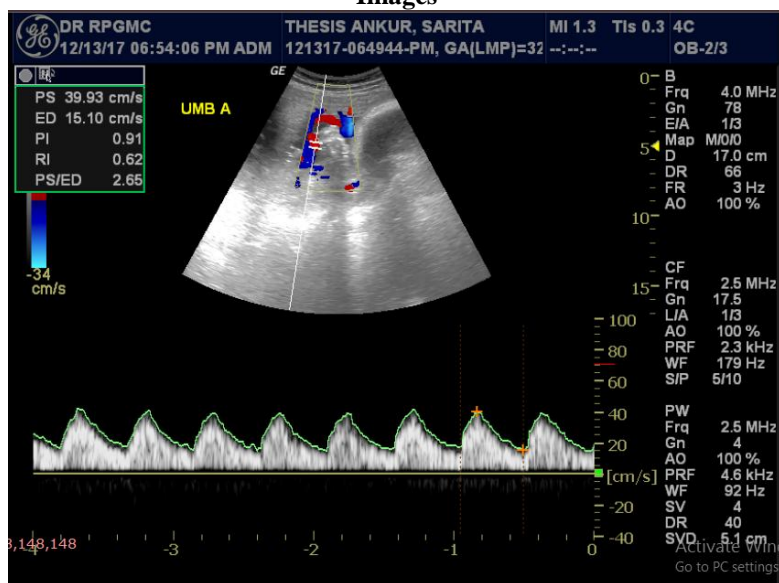
This was a prospective study which was conducted in the Department of Radiodiagnosis in accord with the Department of Obstetrics and Gynecology at Dr. RPGMC Kangra at Tanda, Himachal Pradesh after approval from institutional protocol review committee and institutional ethical committee. All pregnant females >28 weeks of gestation diagnosed of having pre-eclampsia in routine Obstetric and Gynecology OPD were sent for fetal doppler. Pre-eclampsia was defined as the pregnant females with period of gestation >20 weeks with Blood Pressure >140/90 mmHg with proteinuria or edema or both. Pregnant females with chronic hypertension, cardiac diseases and congenital anomalies were excluded from the study.

The study was conducted among 93 pregnant females attending Obstetrics & Gynaecology OPD. Pulsed wave (PW) Doppler ultrasound using Logic p5 GE Healthcare with 3.5 MHz trans-abdominal probe was used to study UA and MCA with respect to PI. All the measurements were performed in recumbent position. The umbilical artery colour Doppler waveform was collected from free floating parts of the umbilical cord during minimal fetal activity. For measurement of MCA, an axial view of fetal head was obtained at the level of cerebral peduncles, then the colour Doppler was used to visualize the Circle of Willis and Doppler sample volume was placed within 1cm of the origin of MCA that was identified as a major branch running antero-lateral from the Circle of Willis toward the lateral edge of the orbit. The angle between the ultrasonographic beam and direction of blood flow was taken <30 degrees.

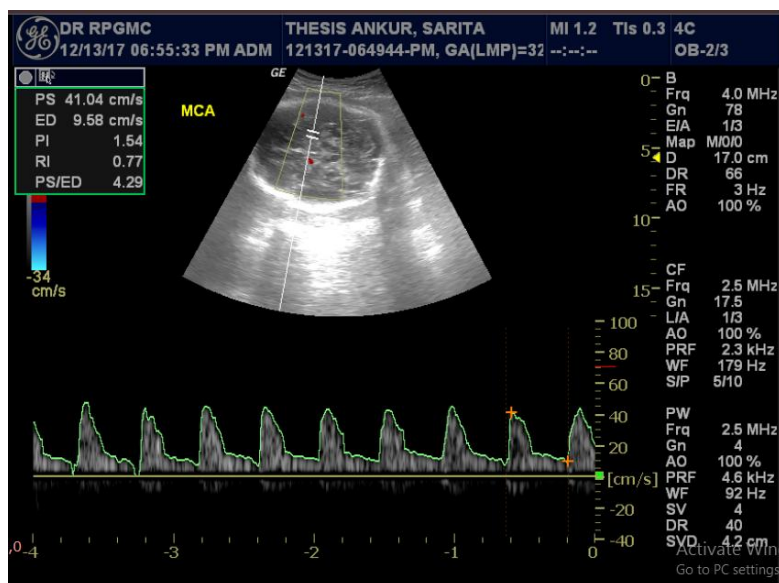
For Cerebroplacental Ratio (CPR = MCA/UA PI) Cut off value of 1 was chosen. All values <1 were considered abnormal as suggested by Yatils et al.<sup>8</sup>

All stated pregnant females were followed up till delivery and perinatally for adverse perinatal outcome such as intrauterine death and neonatal death, cesarean delivery for fetal distress, admission to neonatal intensive care unit, Apgar score below 7 at 5 minutes and IUGR fetuses.

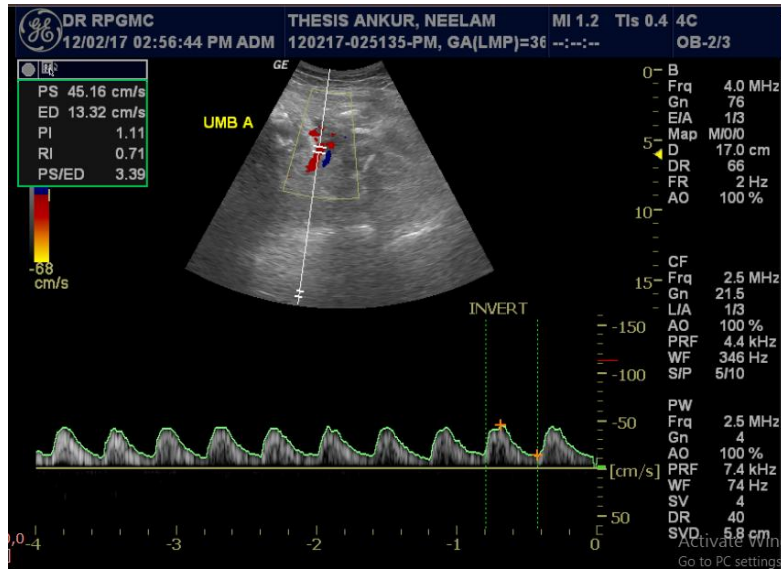
### Images



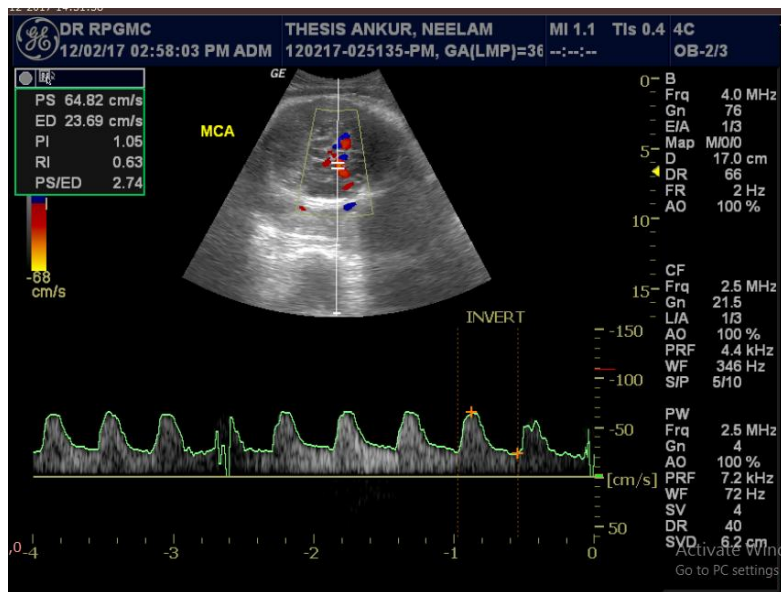
**Normal UA waveform** :25 year old primigravida with pre-eclampsia showing normal umbilical artery flow pattern with normal indices.



**Normal MCA waveflow :**25 year old primigravida with pre-eclampsia showing normal MCA flow pattern with normal flow indices.

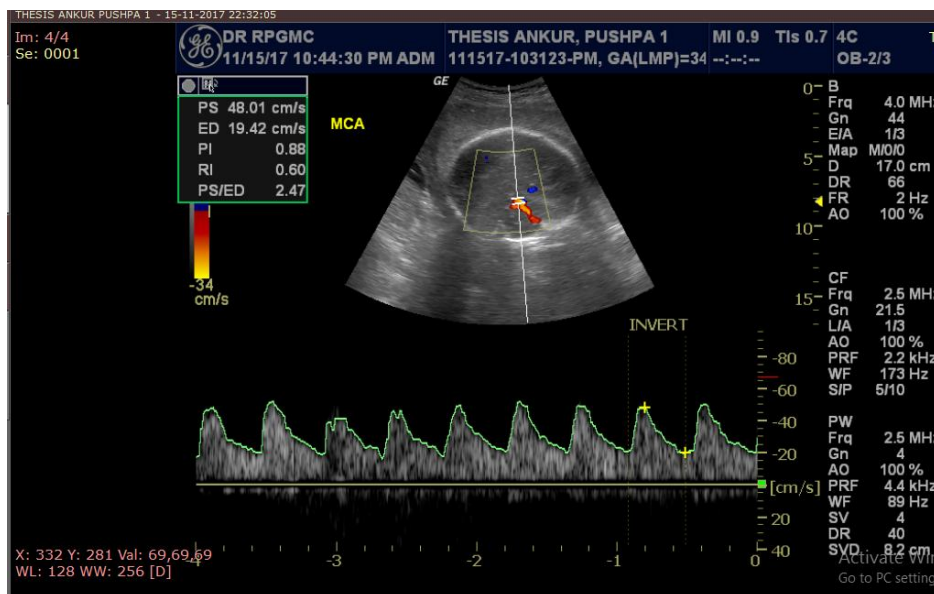


**Reduced UA waveflow:**26years old gravida three with pre-eclampsia shows decreased diastolic flow with elevated RI,PI and S/D.



**Increased diastolic flow**

26 years old gravida three with pre-eclampsia showing increased diastolic flow in MCA. The Cerebroplacental ratio ( MCA/UA S/D & MCA/UA PI in above pregnant female is <1. Emergency LSCS was done in this pregnant female and baby was admitted NICU for fetal distress.



**INCREASED DIASTOLIC FLOW**

28 YEAR OLD PRIMIGRAVIDA WITH PREECLAMPSIA SHOWING INCREASED DIASTOLIC FLOW IN MCA WITH DECREASE IN INDICES S/O “BRAIN SPARING”

**III. Results**

The study was performed on 93 pregnant females who were diagnosed with pre eclampsia. There were 18 pregnant females who had CPR<1. Out of 18 pregnant females 15 had adverse perinatal outcome. There were 2 neonatal deaths, one intrauterine death, two had low Apgar score and ten had NICU admission.

Gravida distribution of pregnant females enrolled in the study is mentioned in the Table 1. Majority of females were primigravida constituting 55% of the pregnant females.

Gravida	Frequency	Percent
1	52	55
2	31	33
3	5	5.3
4	3	3.2
5	1	1.0
6	1	1.0

**Table 1**

Age group distribution is summarized in Table 2. Forty five percent of the pregnant females were between 26-30 years.

Age group (years)	Frequency	Percent
20-25 years	40	43
26-30 years	45	48
31-35 years	6	6.4
36-40 years	2	2.1

**Table 2**

Table 3 depicts distribution of pregnant females in two groups i.e. with CPR > 1( Group I ) and CPR < 1 ( GroupII ) and perinatal outcome in these respective groups.

	CPR >1( Group I )	CPR <1( Group II )
<b>NORMAL PERINATAL OUTCOME</b>	<b>57</b>	<b>3</b>
<b>ABNORMAL PERINATAL OUTCOME</b>	<b>18</b>	<b>15</b>

**Table 3**

Average fetal birth weight in pregnant females with  $CPR > 1$  is 2657 while in pregnant females with  $CPR < 1$  is 2093 grams .

There were 7 pre termbirths out of 75 pregnant females with normal CPR. There were 11 preterm births out of 18 pregnant females with  $CPR < 1$ .

LSCS were performed in 14 out of 75 pregnant females with normal CPR. LSCS were performed in 14 out of 18 pregnant females with  $CPR < 1$ .

Table 4 summarizes perinatal outcome in pregnant females enrolled in the study.

Perinatal outcome	Frequency	Percentage
Normal	60	64.5
NICU admission	22	23.6
Neonatal death	3	3.2
Low APGAR score (at 5 mins<7)	6	6.4
IUD	2	2.1

Table 4

Table 5 compares perinatal outcome in the two groups with respect to NICU admission, neonatal deaths, low Apgar score and Intrauterine death ( IUD ).

PERINATAL OUTCOME	GROUP I ( CPR >1 ) n = 75	GROUP II ( CPR < 1 ) n = 18
Normal	57 ( 76 % )	3 ( 16.6 % )
NICU admission	12 ( 16% )	10 ( 55.5% )
Neonatal death	1 ( 1.3 % )	2 ( 11.1% )
Low APGAR score (at 5 mins<7)	4 ( 5.3 % )	2 ( 11.1% )
IUD	1 ( 1.3% )	1 ( 5.5% )

Table 5

In our study P value was less than 0.0001. The association between groups and outcomes is considered to be extremely statistically significant.

Comparison of our results of the sensitivity, specificity, positive predictive value, negative predictive value of MCA/UA ratio with those of the study of Gramellini et al and Shahinaj R et al.

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Gramellini D	68%	98.4%	94.4%	88%
Shahinaj R	98%	66%	30.8%	99.7%
Our study	45%	95%	83%	76 %

#### IV. Discussion

Advances in Doppler ultrasonography have improved access to the fetal circulation. There has been a great deal of interest in the fetal intracranial vessels.<sup>9</sup>Doppler data combining both umbilical and MCA provide additional information on fetal consequences of the placental abnormality.<sup>10</sup>

Abnormal CPR is associated with adverse perinatal outcome. In normal pregnancies the resistance in MCA is higher than in the umbilical artery at any gestational age. Therefore CPR is greater than 1. The index becomes less than 1 if the flow distribution is in favor of the brain in pathological pregnancies. We observed reduction in placental perfusion and an increase in flow towards the brain. This phenomenon, called the brain sparing effect, is supposed to compensate for fetal hypoxia and is associated most of the time with fetal growth retardation. The cerebrovascular index decreases progressively, as in the normal fetuses so the hypoxia to be compensated by the brain hyperperfusion.<sup>11</sup>

In this study inference was made that cerebroplacental ratio  $< 1$  is associated with unfavourable perinatal outcome in pre eclamptic pregnant females.

The adverse perinatal outcome was determined by perinatal mortality that included neonatal death, IUD, low APGAR Score and NICU admissions. In the high-risk pregnancies, Ott et al.<sup>12</sup> reported that MCA/umbilical artery ratio and also the modified biophysical profile together reduced the risk of the fetal distress. Bahado-Singh RO et al.<sup>13</sup> demonstrated that MCA/umbilical artery ratios were better predictor of perinatal death and other complications than was the umbilical artery alone before 34 weeks of gestation.

According to Gramellini et al. and Arduini et al, assessment of MCA/UA PI index provide better information in predicting perinatal outcome when compared with umbilical or middle cerebral artery Doppler indices alone.<sup>14,15</sup>



Similar to prior studies our study emphasize on the role of cerebroplacental ratio in predicating the adverse perinatal outcome in pregnant females with pre-eclampsia. There was high incidence of LSCS , Low Birth weight, NICU admission, low Apgar score at 5 minutes and increased neonatal deaths in study group with  $CPR < 1$ . In this study the sensitivity of  $CPR < 1$  in predicting perinatal outcome was 45%, specificity was 95%, PPV was 83% and NPV was 76%. In a study conducted by Shahinaj R et al MCA/UA PI ratio  $< 1$  has the higher sensitivity (100%) for stillbirth, higher specificity and positive predicted value for admission to neonatal care unit (79.3% and 77.6%).<sup>16</sup>

Doppler ultrasound of placental and fetal circulation can provide important information regarding fetalwell-being, yielding an opportunity to improve fetal outcome.

Our results suggested that the MCA/UA PI Doppler ratio of less than 1 was a good predictive tool for neonatal outcome in preeclampticpregnant women and could be used to identify fetusesat risk of morbidity and mortality.

The use of Doppler ultrasound in high risk pregnancies appears to improve a number of obstetric care outcomes and promising in reducing perinatal deaths.<sup>17</sup>

In conclusion, CPR was found to be sensitive and specific in theprediction of poor neonatal outcome in pregnancies with preeclampsia. Considering that CPR reflects not only the circulatory insufficiency of the placenta by an alteration in the umbilical PI but also the adaptive changes resulting in modification of the MCA-PI, it seemed to be a potentially useful tool in predicting adverse neonatal outcomes. Therefore, it may help with patient counselling regarding adverse neonatal outcomes in cases of pre-eclampsia in third trimester.

## References

- [1]. Baumwell S. Pre-eclampsia: clinical manifestations and molecular mechanisms. *Nephron Clinical practice* 2007; 106:c72–c81.
- [2]. Cunningham FG, Gant N, Leveno K, Gilstrap L, Hauth J, Wentrom K (2001) Hypertensive disorders in pregnancy. In: Cunningham FG, Williams JW (eds) *Williams obstetrics*, 21st edn. McGraw–Hill, New York (NY), pp 567–618
- [3]. Harrington K, Carpenter G, Nguyen M, Campbell S (1995) Changes observed in Doppler studies of the fetal circulation in pregnancies complicated by pre-eclampsia or the delivery of a small-for-gestational-age baby. I. Cross-sectional analysis. *Ultrasound ObstetGynecol* 6:19–28
- [4]. A.A. Baschat, U. Gembruch, The cerebroplacental Doppler ratio revisited, *Ultrasound Obstet. Gynecol.* 21 (2003) 124–127.
- [5]. R.O. Bahado-Singh, E. Kovanci, A. Jeffres, U. Oz, O. Deren, J. Copel, et al., The Doppler cerebroplacental ratio and perinatal outcome in intrauterine growth restriction, *Am. J. Obstet. Gynecol.* 180 (3 Pt 1) (1999) 750–756.
- [6]. A.A. Baschat, Fetal growth restriction – from observation to intervention, *J. Perinat. Med.* 38 (3) (2010) 239–246.
- [7]. Gramellini D, Folli MC, Raboni S, Vadora E, Merialdi A. Cerebral–umbilical Doppler ratio as a predictor of adverse perinatal outcome. *ObstetGynecol* 1992; **79**: 416– 420.
- [8]. Yalti S, Oral Ö, Gürbüz B, Özden S, Atar F. Ratio of middle cerebral to umbilical artery blood velocity in preeclamptic& hypertensive women in the prediction of poor perinatal outcome. *Indian journal of medical research.*2004 Jul 1;120(1):44.
- [9]. Neilson JP, Alfirevic Z. Doppler ultrasound for fetal assessment in high risk pregnancies. *Cochrane Database Syst Rev* 2000:CD000073.
- [10]. Bahado-Singh RO, Kovanci E, Jeffres A, Oz U, Deren O, Copel J, et al. The Doppler cerebroplacentalratio and perinatal outcome in intrauterine growth restriction. *Am J ObstetGynecol* 1999; 180: 750–6.
- [11]. Rizzo G, Arduini D, Luciano R, Rizzo C, Tortorolo G, Romanini C, et al. Prenatal cerebral Doppler ultrasonographyand neonatal neurologic outcome. *J Ultrasound Med* 1989; 8 : 237–40.
- [12]. Ott WJ, Mora G, Arias F, Sunderji S, Sheldon G (1998) Comparison of the modified biophysical profile to a ‘new’ biophysicalprofile incorporating the middle cerebral artery to umbilical artery velocity flow systolic/diastolic ratio. *Am J ObstetGynecol*178:1346–1353
- [13]. Bahado-Sing RO, Kovanci E, Jeffres A, Oz U, Deren O, Copel J, Mari G (1999) The Doppler cerebroplacental ratio and perinataloutcome in intrauterine growth restriction. *Am J ObstetGynecol* 180:750–756
- [14]. Gramellini D, Folli MC, Raboni S, Vadora E, MerialdiA. Cerebral umbilical Doppler ratio as a predictor of adverse perinatal outcome. *Obstet Gynecol.*1992; 79:416-420
- [15]. Arduini D, Rizzo G. Prediction of fetal outcome in small for gestational age fetuses:comparison of Doppler measurements obtained from different fetal vessels. *J Perinat Med.* 1992;20:29-38.
- [16]. Shahinaj R, Manoku N, Kroj E, Tasha I. The value of the middle cerebral to umbilical artery Doppler ratio in the prediction of neonatal outcome in patient with preeclampsia and gestational hypertension. *Journal of prenatal medicine.* 2010 Apr;4(2):17.
- [17]. Neilson JP, Alfirevic Z. Doppler ultrasound for fetal assessment in high risk pregnancies. *Cochrane Database Syst Rev* 2000:CD000073.