Cerebro-placental Ratio’s Role In Perinatal Outcome Prediction In High-risk Pregnancies With Intrauterine Growth Restriction

AbdelMonem Mohamed Zakaria
Obstetrics & Gynecology department, Faculty of Medicine, Al-Azhar University, Egypt

AbdelMonsef Abdel Ghaffar Mostafa
Obstetrics & Gynecology department, Faculty of Medicine, Al-Azhar University, Egypt

Khalid Abdel hakim Shehata
Resident of obstetrics and gynecology Sohag teachingl Hospital, Egypt, khaledshehata2025@gmail.com

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Cerebro-Placental Ratio's Role in Perinatal Outcome Prediction in High-Risk Pregnancies with Intrauterine Growth Restriction

AbdelMonem Mohamed Zakaria, AbdelMonsef Abdel Ghaffar Mostafa, Khalid Abdel Hakim Shehata*

Department of Obstetrics & Gynecology, Faculty of Medicine, Al-Azhar University, Cairo, Egypt

Abstract

**Background:** The established method of antenatal monitoring known as Doppler ultrasonography velocimetry of utero-placental umbilical and foetal vessels. Studies on the cerebral-placental ratio have been done to anticipate neonatal achievements.

**Aim and objectives:** To assess the impact of intrauterine growth retardation on pregnancy outcomes in the high-risk parturients using the cerebro-placental ratio.

**Patients and methods:** A case control trial, whereas 100 of conceived females shared and similarly distributed to paired collections, each collection includes 50 of women first group: about high-risk conceived females suffering IUGR and the second is control group: about 50 high-risk conceived females with no IUGR. At the time of the research.

**Results:** Cerebro-Placental relation demonstrated importance at cut-off point of 1.03 in the prediction of IUGR with 87.2% in sensitivity, 71.6% of specificity, and the values as the +ve Predictive Value of 83%, and the -ve Predictive Value of 79%.

**Conclusion:** The cerebro-placental value considers a great prediction method for the perinatal results when there is an intrauterine growth restriction and the pregnancy is in high risk.

**Keywords:** Cerebral-placental ratio, Growth restriction, High-risk pregnancies, Intrauterine, Perinatal outcome

1. Introduction

An intrauterine growth retardation (IUGR) exists if the estimated weight of the foetus on sonograms is underneath the 10th percentile age gestation.1

The Obstetricians and Gynecologists of the Royal College rules that the IUGR is 'one of the utmost frequent and difficult complications in recent obstetrics.2

This description makes sense in view of the multiple published definitions, low recognition rate, dearth of gravid women or curative measures, numerous associated diseases, and elevated hazard of perinatal mortality associated with IUGR. The Adult obesity diseases including hypertension and poor cognitive function are all linked to inadequate growth during birth.3

Accurately identifying the foetus that is truly growth-restricted, choosing the best foetal surveillance, and coordinating delivery times are recent contests in the scientific diagnosis of the IUGR. But the ante-natal of the IUGR and identification may improves the outcomes.4

To make recommendations in the most recent studies for the antepartum care of these pregnant, particularly for one single foetus, it is absolutely essential to synthesise and evaluate the strength of the evidence as regards the usage of Doppler velocimetry of the umbilical and middle cerebral
arteries for non-abnormal foetuses with assumed IUGR. This clinical opinion does not primarily address the issue that there are significant differences between employing universal populace charts and customised charts to define the small for age gestation (10th percentile foetus weight for gestational period).

The placenta is the only source of nutrition for the developing foetus. Developmental issues result from the placenta’s limited capacity to give the foetus adequate nutrition during IUGR.

Any failure to adjust results in the development of abnormal vascular resistance patterns, which may ultimately damage the health of the foetus and cause IUGR.

2. Patients and methods

This was a case-controlled trial in which made in the on 100 parturients visiting Al-Hussein Hospital, Al-Azhar University from May 2021 to May 2022. The established candidates were selected into double collections: the first (case collection) included 50 IUGR-positive high-risk pregnant women and the second (control collection) about 50 high-risk conceived females with no IUGR whereas the coloured Doppler of the obstetrics could be assessed.

All conceived women in both collections involved in the research were aged from twenty years or more with single foetus only and Fetal Gestational age was in the third trimester. All under effect of the high-risk pregnant, such as elevated blood pressure due to pregnancy, smoking, knowing their first date of the last menses (LMP), but fetal IUGR in case collection and No fetal IUGR in Control collection, diagnosed by ultrasonography estimated foetal weight for gestational age.

Except the ones whom had Congenital malformations in the current foetus, anaemic patients, polyhydraminos, multi fetal pregnancy, diabetes mellitus with pregnancy, and an uncertain LMP date.

2.1. Ethical considerations

The department of obstetrics and gynaecology at El-Hussien University Hospital. The research ethic committee has accepted the research before presentation.

All cases were examined using the following research techniques:

All study participants were given their informed consent orally and in writing after being informed of the study’s specifics, as determined by the ethical committee.

2.2. Obstetric history

Calculate the gestation age constructed on the last date of the menses, identify a viable singleton pregnancy, and rule out gestational diabetes. Medical and surgical background: asthma, diabetes, herpes simplex infection, chronic hypertension, renal disease, previous myomectomy, and asthma.

2.3. An examination of the body included

Vital signs such as pressure of blood, temperature, pulse, and mass index of body are examined generally. Examining the abdomen reveals a scar from a previous procedure.

2.4. Ultrasound Doppler evaluation

Everyone involved in this trial, estimation of gestational age was determined by ultrasonography (USG) or routine foetal biometry in the first trimester or early second trimester. The middle cerebral and the umbilical arteries underwent Doppler velocimetry.

Doppler velocimetry of the umbilical vessel was accomplished on a freely-floated portion of the center of the umbilicus cord, far of the placenta and the enrollment of the foetus cord.

The umbilicus cord were examined with coloured Doppler flow and the waveforms of each artery’s flow velocity were recorded. Color flow Doppler was used to pinpoint the MCA in the Sylvian sulcus that extends from the Circle of Willis. A stream velocity waveform was obtained after the Doppler sample was positioned in the middle cerebral artery’s first third. It was decided to conduct pulsed wave Doppler ultrasound tests without foetal breathing or movement.

2.4.1. Scanning with ultrasound

Was carried out trans-abdominally using an ultrasound scanner made by Medison R5 that has a 3.5 MHz Convex probe to assess the following: foetus biometrics: as Gestational age (GA), foetal size (FS), femur length (FL), and biparietal diameter (BPD), Foetus Weight.

2.4.2. Doppler studies of the following arteries

The middle cerebral and the umbilical arteries were examined using coloured Doppler sonography and pulsed waved Doppler. All Doppler tests were performed using the 3.5 MHz Convex probe of the
Medison R5 ultrasound equipment. Doppler indices were calculated by the machine’s internal software programmes. S/D is the formula for the systolic/diastolic ratio, whereas S represents the peak systolic frequency and D denotes the finale diastolic frequency. The simplest of all indexes is S/D. This indicator, also referred to as Pourcelot’s ratio, is derived by comparing the peak systolic and end diastolic velocities: as follow:

\[
\text{Resistant Index} = \frac{(S-D)}{S}
\]

**Pulsatility index (PI):** This index is calculated by:

\[
\text{PI} = \frac{(S-D)}{\text{velocity}_{\text{mean}}}
\]

Cerebrop-lacental ratio (CPR) (middle cerebral artery to umbilical artery PI ratio) was estimated. (CPR) ratio is designed on the chart; <5th percentile was considered abnormal Fig. 1.

### 2.4.3. Neonatal evaluation

Data on the perinatal outcome was gathered.

Involved conclusion differences are: decreased APGAR rating (1 min, 5 min and APGAR score<7).

### 2.4.4. Neonatal evaluation based on score of APGAR

The Apgar scoring technique is a helpful clinical tool to determine which newborns need resuscitation and to evaluate the efficacy of any resuscitative measures. Neonatal Death, Admission to NICU: When the above-mentioned complications weren’t existing, the pregnancy’s conclusion was viewed as Without incident or Favorable. Each pregnancy’s outcome was ascertained by reviewing the records from the labour ward, the neonatal intensive care unit, and, when applicable, the CS for foetal distress, meconium aspiration, and stillbirth.

### 2.5. Statistical analysis

Using SPSS 22.0 for Windows, all data were gathered, tabulated, and statistically examined (Chicago, IL, USA). Using the Shapiro-Wilk test, the distribution of the data was examined for normality. Multi-Frequencies and relative percents were employed to represent qualitative information. The difference between the qualitative variables was calculated using the chi square test (\(\chi^2\)) and Fisher exact, as shown. For parametric and non-parametric data, respectively, the mean and SD (standard deviation) were used to express quantitative data. Every statistical comparison used a two-tailed significance test. \(P\) values below 0.05 indicate a significant difference, those above 0.001 a highly significant difference, and those below 0.05 a non-significant difference.

### 3. Results

Tables 1–5.

With a cut-off point of 1.03 and a sensitivity is 87.2%, specificity is 71.6%, PPV of 83%, and NPV of 79%, CPR successfully predicted IUGR Fig. 2, Tables 6 and 7.

### 4. Discussion

The established method of antenatal monitoring known as Doppler ultrasonography velocimetry of utero-placental umbilical and foetal blood vessels. Studies on the cerebro-placental ratio have been done to anticipate neonatal achievements.

We wanted to determine how the cerebro-placental ratio affected the prognosis for perinatal

![Fig. 1. Values of CPR recognition (Ebbing et al., 2007).](image)
The analysis of our data showed that there were no statistical significance alteration between the collections as regard to parturients age, BMI, or parity. The mean age of the case group was 27.33 ± 4.28 years, and the mean age of the control group was 25.77 ± 4.54.

The current study revealed that there is no significant difference between the studied groups regarding IUGR of high-risk pregnancies. Which was supported by study of (El-Kady et al.)9 as they reported that there was no significant difference as regard patient characteristics (age, weight, BMI, and gestational age) between study and control groups whereas mean age being 28.8 ± 3.0 and the control group’s mean age being 29.2 ± 2.8.

Furthermore, (Tolu et al.),10 who included 170 pregnant women with growth-restricted foetuses and found that 133 of them had typical umbilical vessel Doppler results and 37 had defective umbilical vessel Doppler, nearly corroborated our findings. 4 (3%) of the standard and 9 (24.3%) of the atypical umbilical artery Doppler examinations with a value of 0.001 showed neonatal mortality.

Twenty umbilical arteries (15%) and 24 abnormal umbilical arteries (64.9%) were discovered. Doppler study newborns must be reserved to the hospital of neonatal intensive care unit (value: 0.002). (95% CI: 1.449–2.926; OR = 2.059; P-value = 0.002). Complicated growed-retareded foetuses with defective Doppler were doubled as likely to need hospitalizations in newborn intensive care units as growth-restricted foetuses with acceptable Doppler flow of the umbilical vessel.

While conducting the study by Contro et al.,11 they retrospectively retrieved 1000 controls and 53 cases. Both gestational age and IUGR were functions of the regression line with log10 UtA-PI as the reliant variable. In both groups UtA-PI lowered with age gestation. From 20 weeks on, UtA-PI was higher in the IUGR group, and the variance from controls grew with age gestation. Actually, the UtA-PI ratio between the case participants and the control participants at 20 weeks was 1.84, but at 30 weeks it increased to 2.05. Lastly, the IUGR group’s labour weight had an adverse correlation with the UtA-PI values.

In the current study, CPR was significant decreased in case candidates when compared to control candidates, with the CPR Mean SD in the IUGR group being 1.01 ± 0.215 and 1.1 ± 0.228 in the control group.

According to El-Kady et al. study’s9 which supports our findings, patients with IUGR had low CPR in 20 cases (66.7.0%) and normal CPR in 10 cases (33.3%), while patients without IUGR had low CPR in 11 cases (36.7%) and normal CPR in 19 cases (63.3%). This demonstrates that CPR in the IUGR candidates was, decreased statistical significance, most publicity.

<table>
<thead>
<tr>
<th>Table 2. Fetal biometry in the two groups under investigation.</th>
<th>Case-group (n = 50)</th>
<th>Control -group (n = 50)</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bipareital diameter</td>
<td>73.62 ± 4.65</td>
<td>77.16 ± 3.86</td>
<td>2.97</td>
<td>0.004</td>
</tr>
<tr>
<td>Abdominal circumference</td>
<td>23.51 ± 3.92</td>
<td>25.32 ± 3.68</td>
<td>2.38</td>
<td>0.019</td>
</tr>
<tr>
<td>Femur length</td>
<td>54.58 ± 3.98</td>
<td>56.4 ± 3.49</td>
<td>2.43</td>
<td>0.017</td>
</tr>
</tbody>
</table>

The table demonstrates that foetal biometrics were noticeably lower in cases than in controls.

<table>
<thead>
<tr>
<th>Table 3. Neonatal specifications in the two groups of the research.</th>
<th>Control -group (n = 50)</th>
<th>Control -group (n = 50)</th>
<th>t/P</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA (weeks)</td>
<td>37.39 ± 1.08</td>
<td>37.86 ± 0.927</td>
<td>2.34</td>
</tr>
<tr>
<td>Foetus weight (kg)</td>
<td>2.47 ± 0.845</td>
<td>3.08 ± 0.563</td>
<td>3.97</td>
</tr>
<tr>
<td>Apgar on 1 min</td>
<td>6.32 ± 2.37</td>
<td>7.23 ± 0.918</td>
<td>2.53</td>
</tr>
<tr>
<td>Apgar on 5 min</td>
<td>8.81 ± 2.75</td>
<td>9.7 ± 1.09</td>
<td>2.13</td>
</tr>
</tbody>
</table>

The neonatal features of the groups differ significantly from one another. As a result, cases had significantly lower GA, foetus weight, and score of Apgar at 1 and 5 min comparing to controls.

<table>
<thead>
<tr>
<th>Table 4. Relationship of CPR to other factors in the cases group.</th>
<th>Cerebro-placental ratio(CPR)</th>
<th>r</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA</td>
<td>0.300</td>
<td>0.062</td>
<td></td>
</tr>
<tr>
<td>Foetus weight</td>
<td>0.371</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Apgar on 1 min</td>
<td>0.332</td>
<td>0.009</td>
<td></td>
</tr>
<tr>
<td>Umbilical RI</td>
<td>-0.315</td>
<td>0.012</td>
<td></td>
</tr>
<tr>
<td>Middle cerebral RI</td>
<td>0.421</td>
<td>0.003</td>
<td></td>
</tr>
</tbody>
</table>

This table demonstrates a significantly positive correlation between CPR and middle cerebral artery RI, Apgar at 1 min, and foetus weight, while there a significance negative relation between CPR and umbilical vessel RI.
Furthermore (El Ktatny et al.,12) they demonstrated that assessing the capable utility of the CPR assessed at 34–37 weeks of gestation in prediction the perinatal outcomes of the gravid females with FGR. In 50% of the patients, the mean UAD-PI was normal; in the other 50%, it was abnormal. It varied from 0.47 to 2.5. The mean MCD PI was 1.33±0.38, normal in 47.5% of patients and abnormal in 52.5%, with a range of 0.71–2.

Ebrashy et al.,13 reported abnormal cerebroplacental ratio in 84.2% of preeclampsia cases with IUGR and 41.8% of preeclampsia cases without IUGR.

Bernstein et al.,14 revealed that foetus fat and lean body mass have different growing features and the calculation of the foetus fat might be a more sensitive and specific technique of recognition of atypical foetal growth when comparing with lean body mass.

The current study says, we discovered that foetal biometrics were significantly decreased in case candidates than in controls. These results agreed with the results of Larciprete et al.,15 whereas they revealed that the humerus and abdominal circumferences of IUGR foetuses were

![Table 5. Neonatal outcomes (APGAR, foetal distress, Aspirate Meconium, hypoxic-ischaemic encephalopathy, and NICU admission) decreased all candidates and significantly different in between the groups.]

<table>
<thead>
<tr>
<th>Case participants (n = 50)</th>
<th>Control participants (n = 50)</th>
<th>χ²</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low APGAR</td>
<td></td>
<td>9</td>
<td>0.003</td>
</tr>
<tr>
<td>Fetal distress</td>
<td></td>
<td>6.78</td>
<td>0.009</td>
</tr>
<tr>
<td>Aspirate Meconium</td>
<td></td>
<td>7.14</td>
<td>0.008</td>
</tr>
<tr>
<td>Hypoxia- ischaemic encephalopathy</td>
<td></td>
<td>4.89</td>
<td>0.027</td>
</tr>
<tr>
<td>NICU Admission</td>
<td></td>
<td>12</td>
<td>0.000</td>
</tr>
<tr>
<td>Still birth</td>
<td></td>
<td>2.04</td>
<td>0.153</td>
</tr>
<tr>
<td>Death</td>
<td></td>
<td>2.84</td>
<td>0.092</td>
</tr>
</tbody>
</table>

This table demonstrates that low CPR accurately predicts neonatal death in the IUGR group 42% of the time, and accurately predicts neonatal death in the non-IUGR group 64% of the time.
significantly smaller than those of controls, which is consistent with our findings. Most of the SCTT readings were varied between the compared collections.

In furthermore to our research results, Between the groups, we found a substantial variation in neonatal features, also we revealed that there is positive significance relation among foetus weight CPR, score of APGAR at 1 min and MCA RI. While there is negative Significance variations exist between the groups for decreased APGAR score, foetal distress, aspirated meconium, hypoxic-ischaemic encephalopathy, and NICU hospitalisation.

The neonatal outcomes were all examined in the study by Sengodan and Mathiyalan, including foetus weight, Apgar scores at one and 5 min, the need and the length of stay for NICU hospitalization, and perinatal death.

Nathithca and Chusana conducted prospective-cohort research, and they clarified the conclusion that the positive predictive value of CPR was significantly in elevation. As a result, it could be used to stratify gravid females whom may actually got benefits from continued monitoring of her foetus cardiac rate.

Finally, CPR demonstrated significance in the current study for prediction the intrauterine growth retardation with sensitivity 87.2%, specificity 71.6%, PPV 83%, and NPV 79% at cut-off point of 1.03.

The El-Kady et al. The results of the study demonstrated that lower cerebro-placental ratio in the IUGR case candidates had 100.0% sensitivity, 41.7% specificity, 53.3% diagnostic accuracy, 30.0% positive predictive value, and 100.0% negative predictive value to predict hypoxic ischemic encephalopathy. However, lower CPR in non IUGR candidates had 100% sensitivity, 100% negative predictive value, 100% positive predictive value, 65.5% specificity, 66.7% diagnostic accuracy, and 9.1% positive predictive value to predict hypoxic ischemic encephalopathy, too.

Therefore, in study groups, low CPR displayed sensitivity elevation and a low specificity for predicting hypoxic-ischaemic encephalopathy.

4.1. Conclusion

The only approved effective intervention for IUGR pregnancies is delivery at the moment. In our study, low CPR is closely connected to a poor pregnancy outcome, particularly when combination with IUGR. The cerebro-placental relationship has an important inspective value for the perinatal outcomes when there is an intrauterine growth restriction and the pregnancy is at high risk.

Conflicts of interest

None declared.

References