

Cerebro-placental ratio: A useful predictor of perinatal outcomes in preeclampsia

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Abstract

Aim: The aim of this study was to assess the cerebro-placental ratio and its influence on postnatal outcomes in pregnancies complicated with preeclampsia in Albania. Evaluation of this ratio and its values were determined based on fetal outcomes.

Methods: In this study there were involved 106 patients diagnosed with preeclampsia or gestational hypertension hospitalized in the “Queen Geraldine” University Hospital in Tirana during the time period 1 October 2010 – 31 July 2012. For each patient, a Doppler flow velocity was performed and the result of the last examination conducted before labor was taken into consideration. The cerebro-placental ratio (PI ACM/PI AU) was considered abnormal or inverted when its value was lower than one. The fetal wellbeing was assessed immediately after delivery and in the first days after birth. The corresponding values were determined.

Results: Patients were evaluated based on their mothers’ age, prematurity, Apgar in the first and the fifth minute, method of delivery, corresponding IUGR, or fetal weight. Mortality and morbidity of newborns were evaluated based on their ratio of cerebro-placental blood flow in utero. The same evaluation including amniotic fluid was the basis of evaluation for IUGR, preeclampsia severity and fetal outcomes.

Conclusions: Cerebro-placental blood flow velocity can be used to decide the time of delivery for preeclamptic women. Fetal outcome is often compromised in cases with inverted flow velocity. Abnormal cerebro-placental blood flow velocity results in a higher rate of Cesarean section delivery. Morbidity and mortality indicators may be improved if the cerebro-placental ratio is considered.

Keywords: cerebro-placental ratio, perinatal outcomes, preeclampsia.

Introduction

Hypertensive disorders represent the most common complications of pregnancy, with a reported incidence from 5%-10% of all pregnancies (1). These disorders are a major cause of maternal and perinatal morbidity and mortality (2). For mothers, one of the earliest characteristics of the disease is the scarce infiltration of the spiral arteries from the trophoblast, thus, not turning them in uteroplacental arteries (3). This affects the blood flow in the uterine artery (4). In the fetus, there is a poor vascularisation of the terminal villi, stromal villous hemorrhage and hemorrhagic endovasculitis (5,6), or even obliteration of the chorionic villi (7,8).

Being a non-invasive technique in studying the blood circulation, echo-Doppler has become one of the best methods to examine the fetal and maternal circulation measuring flow velocity in the umbilical artery and the cerebri media artery.

The cerebro-placental ratio (cerebri media artery PI/umbilical artery PI) is an indicator of the distribution of fetal peripheral circulation and, in the AGA fetuses, it is >1 (9). Lower values of this ratio (when the ratio is nearly one or lower), are considered pathological. Under these conditions, there is a considerable vasospasm in most fetal territories, like pulmonary, splancnic, skeletal and muscular, and an increase in the perfusion of brain, heart and adrenal glands (10-14). This phenomenon, known as "brain-sparing", intends to compensate the fetal hypoxia as an adapting mechanism to prevent severe brain damage (15). The cerebro-placental ratio is also reported as a good predictor of fetal outcome and can be used to identify fetuses at risk for morbidity and mortality (16-19). It is strongly related to fetal hypotrophy, low birth weight and low pH, a shorter time of delivery and a need for emergent labor (20).

The aim of this study was to assess the role of

cerebro-placental ratio as a predictor of adverse perinatal outcomes in pregnancies complicated by preeclampsia in Albania.

Methods

In this study there were involved 106 patients diagnosed with preeclampsia or gestational hypertension hospitalized in the "Queen Geraldin" Gynecologic-Obstetric University Hospital in Tirana during the time period 1 October 2010 – 31 July 2012.

Patients were assessed according to their age, parity, presence of concomitant diseases, place of residence, gestational age confirmed by the date of the last menstruations as well as by ultrasound, method of labor (by Cesarean section or vaginal delivery) and the presence of complications of severe preeclampsia like HELLP syndrome and eclampsia.

In every patient there was performed a Doppler flow velocity and the result of the last examination conducted before labor was taken into consideration. The cerebro-placental ratio (PI ACM/PI AU) was considered abnormal or inverted when its value was lower than 1.

For the newborns, there were evaluated the following indicators: Apgar score in the first and the fifth minute, birth weight, prematurity, size according to gestational age, SGA, AGA or LGA, presence of fetal hypotrophy (IUGR), amount of amniotic fluid (normal or reduced) and perinatal mortality.

Results and Discussion

To evaluate the role of flow velocity in the pregnancies complicated with preeclampsia, the patients and the newborn were divided into two groups related to the MCA/UA ratio (whether it is normal or inverted). The respective results are shown in Table 1 and Figures 1-2.

Table 1. Characteristics of the patients by MCA/UA ratio (normal vs. inverted)

Characteristics	MCA/UA >1 (normal)	MCA/UA <1 (inverted)	P
Patients average age	29.57±3.4 years	28.86±3.0 years	NS
Average gestational age	37.07 weeks	32.78 weeks	
<i>Delivery method:</i>			
Cesarean section	94%	100%	P<0.05
Vaginal delivery	6%	0%	
Newborn's average weight	2832 gr	1658 gr	P<0.05
Prematurity	40%	73%	P<0.05
IUGR	28%	65%	P<0.05
Reduced amniotic fluid	27%	62%	P<0.05
Perinatal mortality	4%	54%	P<0.05
Preterm babies mortality	9%	74%	P<0.05
Apgar <7 in the fifth minute	3.5%	23%	
<i>Average Apgar:</i>			
First minute	8.23	6.8	
Fifth minute	9.49	7.38	

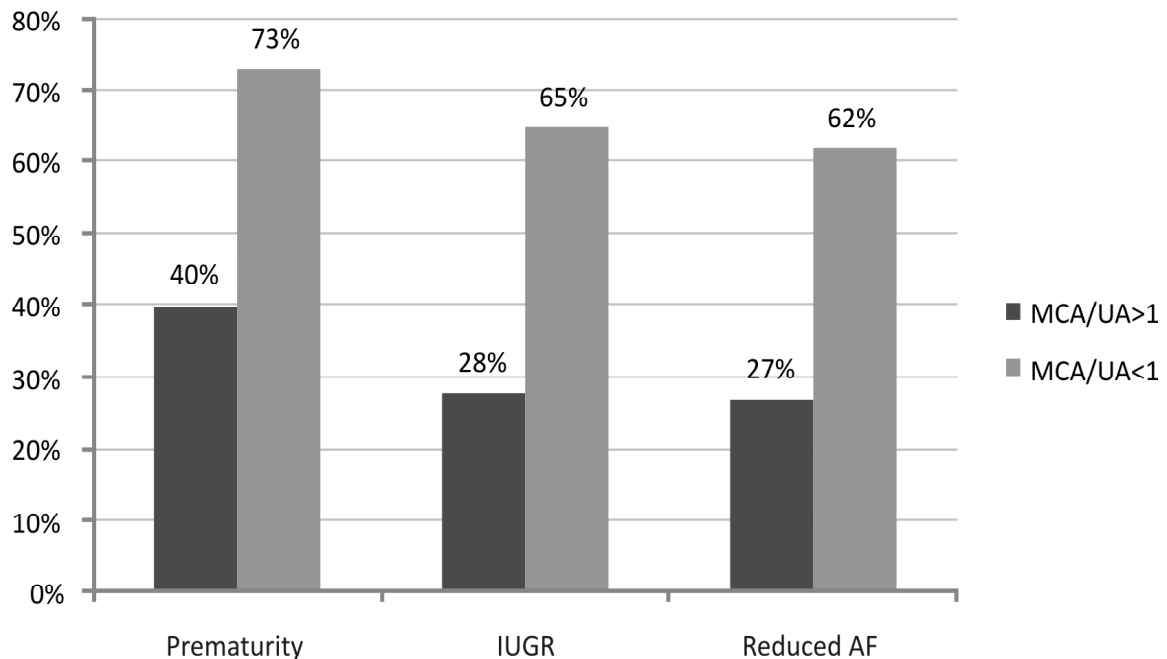
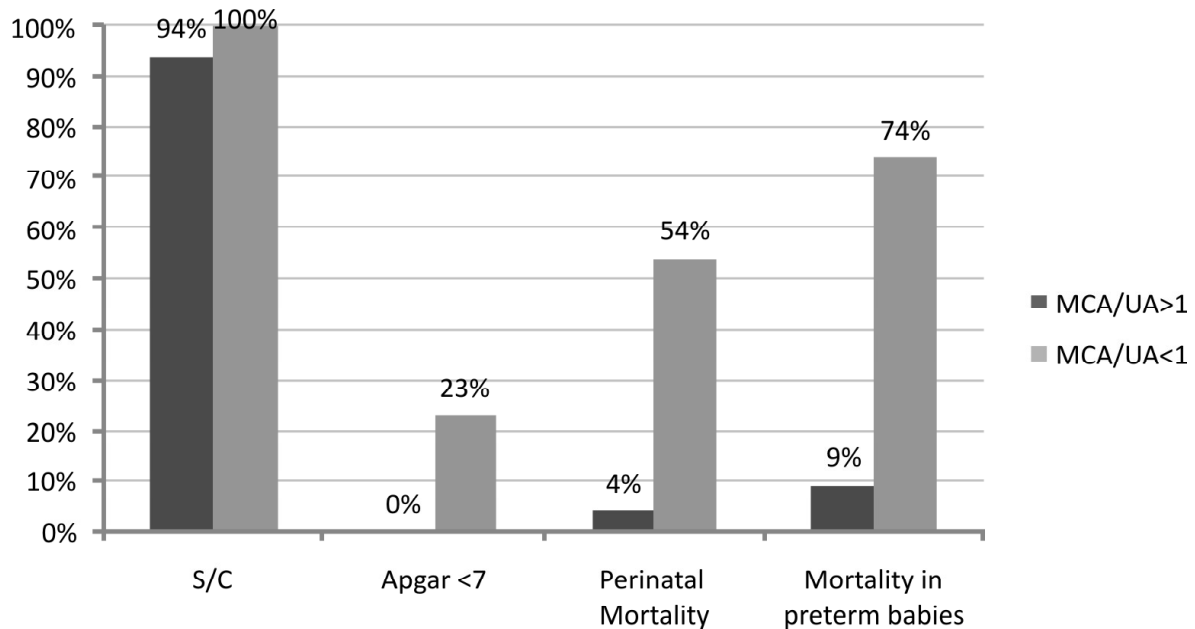
Figure 1. Prematurity, IUGR, and reduced AF related to flow velocity

Figure 2. Delivery method, Apgar and perinatal mortality related to flow velocity**Patients' age**

In our study the average patients' age was 29.02 years old.

Average age in our study was generally higher than other similar studies.

In our study, most of the patients were pregnant for

the first time and, therefore, we can conclude that the age of the first pregnancy in Albanian women has increased.

Yet, in our study, we had patients of over 39 years old (10.38% of all patients), which has a considerable effect on the average age.

Studies	Patients' average age	
	MCA/UA >1	MCA/UA <1
Serap Yalti et al. (21)	27.6±6.9 years old	29.1±7.5 years old
<i>Our study</i>	28.86±3.0 years old	29.57 ± 3.4 years old

In our study, as in another international study (21), there was no significant difference between the inverted flow and average age. Even statistically, age difference was not significant ($P>0.05$).

Average gestational age

Gestational age in our study was calculated in two

ways: in the first day of the last menstruations and by ultrasound, which resulted, respectively, 36.0 weeks and 34.5 weeks. There was a difference between them because in the cases with preeclampsia fetal hypotrophy was very common (in our study it was present in 37% of the cases).

Studies	Average gestational age	
	MCA/UA >1	MCA/UA <1
Simanaviciute D, Gudmundsson S. (22)	35.0 weeks	31.2 weeks
Serap Yalti et al. (21)	37.3±1.6 weeks	37.5±1.9 weeks
<i>Our study</i>	37.07 weeks	32.78 weeks

In our study, as in other similar studies, the difference in the gestational age in weeks between the group with normal flow and the one with inverted flow was almost the same. The inverted flow group had a lower gestational age than the normal group due to the fact that the inverted flow occurs more often in severe preeclampsia which presents earlier and also because IUGR and other fetal problems are complicated with inverted flow more often than pregnancies on term, or near the term.

Grade of preeclampsia

According to the results obtained from the patients

in this study, 64% of them had severe preeclampsia, 33% had moderate and only 3% had mild preeclampsia. The difference between these results was also statistically significant ($P < 0.05$). This high number of cases with severe preeclampsia can be explained by the fact that these patients need to be hospitalized for a more specialized treatment.

Parity

In our study, primiparous cases were visibly higher, with 62% of all the cases, against 38% multiparous cases, similar to other studies, considering that primiparity is one of the well-established risk factors of preeclampsia.

Studies	Parity	
Simanaviciute D, Gudmundsson S (22)	73.90%	26.10%
Oluranti B et al. (23)	51.6%	48.4%
Helewa M et al. (24)	64%	36%
<i>Our study</i>	62%	38%

Delivery method

If we compare the percentage of Cesarean sections related to flow velocity with other studies

(21,22,26), one can note that in our study these values were higher in both groups.

Studies	Cesarean Section	
Simanaviciute D, Gudmundsson S (22)	66.70%	93.10%
Serap Yalti et al. (21)	35.30%	75%
Eser A et al. (26)	66%	88.46%
<i>Our study</i>	94%	100%

The high number of S/C in the cases with inverted flow is explained by the fact that this phenomenon is an indication for immediate interruption of pregnancy. Something to be further discussed or studied is the fact that even in the cases with normal flow velocity, S/C is performed in a much higher percentage in Albania compared with other countries.

Prematurity

In this study, prematurity was high (48%), almost the same as term deliveries. Compared to other studies, premature deliveries in Tirana were more frequent than in other countries. This can be explained by the fact that in our hospital there are many hospitalized patients from other cities, which are always severe cases, in need for a more specialized treatment.

Studies	Prematurity <37 weeks
Buchbinder et al. (27)	66.70%
Hnat et al. (25)	33.00%
Helewa M et al. (24)	37%
<i>Our study</i>	48%

This argument is based on the data of the place of residence of the patients included in this study, which showed that 44% of the patients were residents in Tirana, while most of them (56%) were from other cities. The difference between preterm cases with normal and inverted flow velocity cases (respectively, 40% against 73%), was also statistically significant ($P<0.05$).

In Utero Growth Retardation (IUGR) and reduced amniotic fluid (AF)

These two pathologies resulted in high rates (IUGR 37%, reduced AF 35%) compared to other studies due to the fact that in this hospital in Tirana there are many cases from other cities (56% compared to 44% from Tirana), which are always severe cases.

Studies	Fetal hypotrophy
Buchbinder et al. (27)	16.20%
Hauth et al. (28)	28.70%
Harrington et al. (29)	35.20%
<i>Our study</i>	37%

These pathologies also have a strong association between them, noticing that 73% of IUGR fetuses are preterm and 58% of IUGR fetuses have reduced AF. Furthermore, these pathologies are strongly related to flow velocity.

IUGR was found in 28% of the cases with normal flow velocity and in 65% of the cases with

inverted flow velocity ($P<0.05$), because not only IUGR is an important factor of delivery, but also due the evaluation of flow velocity which influenced a higher percentage of delivered cases. This means that in cases with hypotrophy, delivery was made after the flow velocity was inverted.

Studies	Fetal hypotrophy	
	MCA/UA>1	MCA/UA<1
Simanaviciute D, Gudmundsson S (22)	26.20%	71.40%
<i>Our study</i>	28%	65%

In cases with inverted flow velocity, it was also more frequent the presence of reduced AF (62% compared to 27% of the patients with reduced AF in the cases with normal flow velocity; $P<0.05$).

Apgar score

Average Apgar of the first minute in our study was

7.9 which was higher compared to other studies. This result shows that application of S/C delivery at such a high rate is effective related to the fetal outcome, since in other countries that apply this mode of delivery in a lower percentage, the newborn's Apgar immediately after delivery is lower.

Studies	Apgar <7 fifth minute	
	MCA/UA>1	MCA/UA<1
Simanaviciute D, Gudmundsson S (22)	4.80%	10.30%
<i>Our study</i>	3.50%	23%

A significant difference can be noticed in the cases with inverted flow, where Apgar <7 in our study was found in 23% of the cases. The way of delivery and adaption of the newborn in the fifth minute in these cases must be reconsidered though. This means that, physicians in Tirana should not always wait for inversion of the flow velocity in order to perform delivery, since this is associated

with more complications and neonatal mortality.

Newborn's average weight

In our study, similar to other studies (21,22), there was a difference of more than 1000 gr in the newborn's weight, which can be explained with prematurity and fetal hypotrophy which influence birth weight and which are always at high rates in the newborns with inverted flow.

Studies	Newborn's average weight	
	MCA/UA>1	MCA/UA<1
Serap Yalti et al. (21)	3292.9 gr	2892.5 gr
Simanaviciute D, Gudmundsson S (22)	2319.1 gr	1364.1 gr
<i>Our study</i>	2832 gr	1658 gr

Perinatal mortality

In our study, perinatal mortality was present in 15% of the cases, which is considered high, compared to other similar studies. Various arguments can be used to explain this high level of perinatal mortality in our study:

- High percentage of prematurity in the cases of our study in Tirana (48%).
- High rate of mortality in premature cases (31%).
- High percentage of newborns with Apgar <7 in the fifth minute, which is related to neonatal

adaptation.

- Strong association of mortality with inverted flow (82% of the deceased babies).
- Fetal hypotrophy (IUGR) in the major part of the deceased babies (65%).
- The major part of the patients (64%) had severe preeclampsia, which is related to a higher neonatal morbidity and mortality, mostly in cases when its major complication (HELLP syndrome) is developed. In our study, this complication was related to a mortality of 50%.

Studies	Perinatal mortality
Hnat et al. (25)	1.40%
Hauth et al. (28)	2.80%
Begum MR et al. (30)	3.13%
Buchbinder et al. (27)	8.90%
Oluranti B et al. (23)	37%
Gong Yun-hui et al. (31)	10.8%
Murotsuki J et al. (32)	16.7%
<i>Our study</i>	15%

The relation between flow velocity and mortality can be confirmed by the fact that in the cases with inverted flow, mortality was 54% against 4% in the babies with normal flow. The difference was high (50%), and it was also statistically significant ($P < 0.05$).

In the last point of discussion about perinatal mortality related to flow velocity, it was considered only the rate of mortality in preterm cases. This argument intends to establish if there is a relation between the inverted flow and neonatal mortality, since all the deceased babies part of this study were preterm, and can be assumed that the cause of death was prematurity, regardless of the inverted or normal flow.

Hence, in cases with inverted flow, mortality in preterm babies was 74%, whereas in cases with normal flow it was only 9%. Thus, even though preterm, babies with normal flow had a more than 60% lower mortality compared to those with

inverted flow, with a statistically significant difference ($P < 0.05$). These results clearly show the important influence of flow velocity on perinatal mortality.

Conclusions

- In this study conducted in Tirana, low velocity seems one of the evaluation methods to select the best delivery time in patients with preeclampsia for reducing the complications for the mother and the fetus.

- Fetal outcome is often compromised in cases with inverted flow velocity.

- The higher rate of S/C deliveries in cases with preeclampsia has a positive influence on fetal outcomes.

- The value of C/P ratio is very important for the evaluation of perinatal morbidity in preeclampsia. The correct intervention will reduce perinatal mortality in Albania.

Conflicts of interest: None declared.

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