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Relation between Fetal Doppler Indices in Patients with Severe Preeclampsia at or above 34 Weeks of Gestation and Neonatal Outcomes

Mohammed Mohammed Gebril
Department of Obstetrics and Gynecology, Al-Azhar University, Faculty of Medicine for boys, Cairo, Egypt

Ahmed Mohammed El Sadek
Department of Obstetrics and Gynecology, Al-Azhar University, Faculty of Medicine for boys, Cairo, Egypt

Mohammed Adel Mostafa
Department of Obstetrics and Gynecology, Al-Azhar University, Faculty of Medicine for boys, Cairo, Egypt, dolarismarginalisoppof11@gmail.com

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ORIGINAL ARTICLE

Relation Between Fetal Doppler Indices in Patients with Severe Preeclampsia at or Above 34 Weeks of Gestation and Neonatal Outcomes

Mohammed Mohammed Gebril, Ahmed Mohammed El Sadek, Mohammed Adel Mostafa*

Department of Obstetrics and Gynecology, Al-Azhar University, Faculty of Medicine for Boys, Cairo, Egypt

Abstract

Background: **Noninvasive Doppler flow velocimetry of the umbilical artery and cerebral circulation is utilized to measure fetal well-being. Doppler scans are more precise and might be a beneficial tool in predicting a negative perinatal outcomes in high-risk individuals.**

Aim and objectives: **The aim of this study is to evaluate the relation between the results of the uterine and fetal Doppler Indices of the umbilical and middle cerebral arteries in Women with Severe Eclampsia at or above 34 Weeks of Gestation and Neonatal Outcomes.**

Patients and methods: **This case-control research included 100 pregnant women who visited Al-Azhar University Hospital's obstetrics and gynecology department. They were split into two groups: (group 1): enrolled 50 pregnant women with severe preeclampsia at or after 34 weeks of gestation, (group 2): included 50 normal pregnant women at or after the 34th week of the gestation, from April 2021 to December 2021.**

Result: **There is statistically significant difference between cases and controls regarding fetal complications as newborn intensive care unit (NICU) admission, Respiratory distress syndrome (RDS), intrauterine growth retardation (IUGR), intrauterine fetal death (IUFD) and 5-min APGAR score less than 8.**

Conclusion: **There is a strong correlation between the Middle cerebral artery (MCA)/UA pulsatility index (PI) and MCA/UT (PI) ratio and neonatal outcome; it was revealed that a normal MCA/UA (PI) and MCA/uterine (PI) ratio is a strong predictive of a normal fetal finding, while an abnormal value is strongly associated with neonatal morbidity.**

Keywords: Doppler velocimetry, Middle cerebral artery, Preeclampsia, Umbilical artery, Uterine artery

1. Introduction

One of the most important unresolved issues in obstetrics is hypertensive disorders during pregnancy. 5−10% of all conceptions are complicated by hypertensive disorders, which combined with bleeding and infection form the fatal trifecta that significantly increases maternal morbidity and death.[1]

Preeclampsia is characterized by the start of new hypertension after 20 weeks of pregnancy and the presence of signs of maternal organ failure. Preeclampsia rates have consistently risen over the last 30 years, impacting around 4% of pregnancies in the US, and posing a significant financial burden.[2]

An increase in maternal, perinatal, and newborn mortality is also attributed to preeclampsia. It causes more than 70.000 maternal deaths annually, 500 000 prenatal and postnatal deaths annually, and it is the second leading reason of maternal death worldwide. It can also cause complications for the mother, including stroke, eclampsia, and organ failure, as well as poor perinatal outcomes for the fetus and infant, including intrauterine advancement restriction, low birth weight, and stillbirth.[3]

Preeclampsia, which accounts for 15% of all preterm births, is a primary cause of premature labor and results in a longer stay for the mother or the infant in critical care units, which raises healthcare expenses.[4]

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* Corresponding author at: Resident of Obstetrics and Gynecology at Beni Surf specialized Hospital, 11844, Egypt. Fax: 01003301360.
E-mail address: dolarismarginalisoppof11@gmail.com (M.A. Mostafa).

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Doppler ultrasonography (US) may identify the decreased placental perfusion brought on by vascular anomalies before clinical PE symptoms. The latter has been regarded as an effective technique for PE prediction and pregnancy outcomes that are unfavorable.[5]

Both histology investigations and the clinical severity of PE are correlated with the Doppler ultrasonography used to measure blood flow resistance in the uterine arteries.[6]

A healthy pregnancy result depends on the uteroplacental and tetoplacental circulation developing well. Premature birth, subnormal growth intrauterine growth retardation (IUGR), or fetal mortality may all be caused by obstructed circulation, which is linked to hypertensive in gestation.[7]

The study aimed to evaluate the relation between the results of the uterine and fetal Doppler Indices of the umbilical and middle cerebral arteries in people with Severe Preeclampsia at or above 34 weeks of Gestation and Neonatal Outcomes.

2. Patients and methods

From April 2021 to December 2021, 100 pregnant women who visited the Obstetrics and Gynecology Department at Al-Azhar University Hospital participated in this case-control research. The women were separated into two groups: Group 1: 50 pregnant women with severe preeclampisa at or after 34 weeks of gestation. Group 2: normal pregnant women at or after the 34th week of the gestation.

2.1. Sample size justification

The original trial's sample size was determined based on Adekanmi and colleagues[8] with an equation $n = N^* X/(X + N\text{-}1)$ where $x = Z\alpha/22^\circ *p*(1\text{-}p)/e2$ and $Z\alpha/2^\circ$ is 1.96 at confidence level of 95%, α error is 0.05, e = significance level (0.05), *P* is sample percentage, and N is the population size. The sample size requirement was 98 instances. To compare a drop-out and incomplete cases and to ensure that this number was achieved in the analysis, sample size was raised to 100 cases.

2.2. Inclusion criteria for study group

Pregnant patients age 18–40 years old, single living fetus 34 weeks gestation that was measured by the first day of last menstrual period or by first trimester ultrasound scan estimation for those who were unsure of last menstrual period, According to the research group's definition of severe preeclampsia, which includes proteinuria, uncontrolled blood pressure, and ultrasound measurements of intrauterine growing restriction, blood pressure greater than 160/110 mmHg on two or more dates; 4–6 h apart with proteinuria of more than 300 mg in 24 h urine samples collected or higher than one plus proteinuria in dip stick specimens and/or oligohydramnios (AFI) and patients who underwent termination of pregnancy by lower segment cesarean section (LSCS) within 24 h after diagnosis.

2.3. Exclusion criteria

Rupture of membrane confirmed with a sterile speculum examination, multiple gestations, fetal congenital abnormality, ante partum hemorrhage, intrauterine fetal death, smoking, Persistent medical issues such placenta previa, persistent hypertension, sickle cell disorder, and diabetes mellitus.

2.4. Methods

Patients were subjected to:

Complete history taking: Maternal and gestational age, history of Gravidity, history of Parity, date of last menstrual period, present History of any disease or medication, past history of any disease, obstetric history, family history of this condition, surgical history, obstetric history (number of births, the kind of delivery, and the history of miscarriages and ectopic pregnancy), history of drug intake, history of diabetes mellitus or hypertension and past history of bleeding tendency, blood diseases, family history of similar condition.

Examination: General examination: Vital signs (Temperature, Blood Pressure, Pulse Rate, and Breathing Rate), Signs of (Pallor, Cyanosis, Jaundice, and enlargement of the lymph nodes), Blood pressure measurement (2 blood pressure readings were obtained 6 h apart) and signs of edema were elicited. Abdominal ultrasonographic examinations (at or after 34 weeks: were performed by one investigator using a 3.5–5 MHz) transabdominal probe or assessment of: Fetal well-being, Fetal presentation, Amniotic fluid index. Fetus biometry and biometric measurements (BPD, AC, FL, and HC) were used to estimate fetal weight utilizing the Hadlock IV formula (1985) Fig. 1.

Doppler ultrasonographic examinations: Doppler velocimetry for the Uterine artery: The S/D ratio, the mean pulsatility index (PI), and the resistive index (RI) were all recorded. Before the final result was calculated, a minimum of three distinct readings were averaged Fig. 2.

Doppler velocimetry for the umbilical artery: The resistive index (RI) and pulsatility index (PI) were calculated, as well as the S/D ratio. Before the final

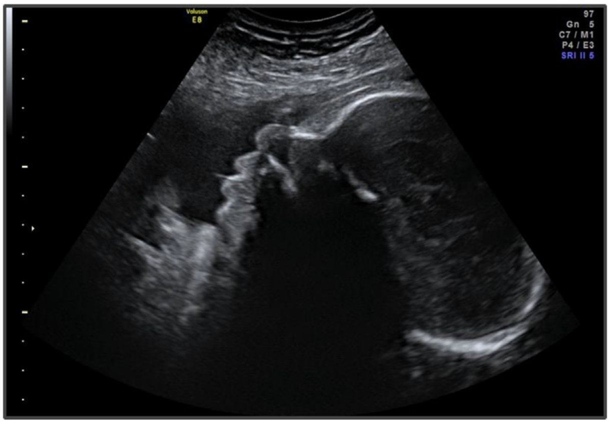

Fig. 1. Ultrasound image of fetus at 35 weeks gestation.

result was calculated, a minimum of three distinct readings were averaged Fig. 3.

Doppler velocimetry for the Middle cerebral artery (MCA): The Middle cerebral artery's median RI, PI, and S/D ratio were calculated. Before the final result was calculated, a minimum of three distinct readings were averaged Fig. 4.

Follow-up till Termination of pregnancy.

2.5. Outcome

The following was estimated for each case as follows: Neonatal outcome: hospitalization to newborn intensive care unit (NICU) due to Respiratory distress syndrome (RDS) or aspiration of meconium,

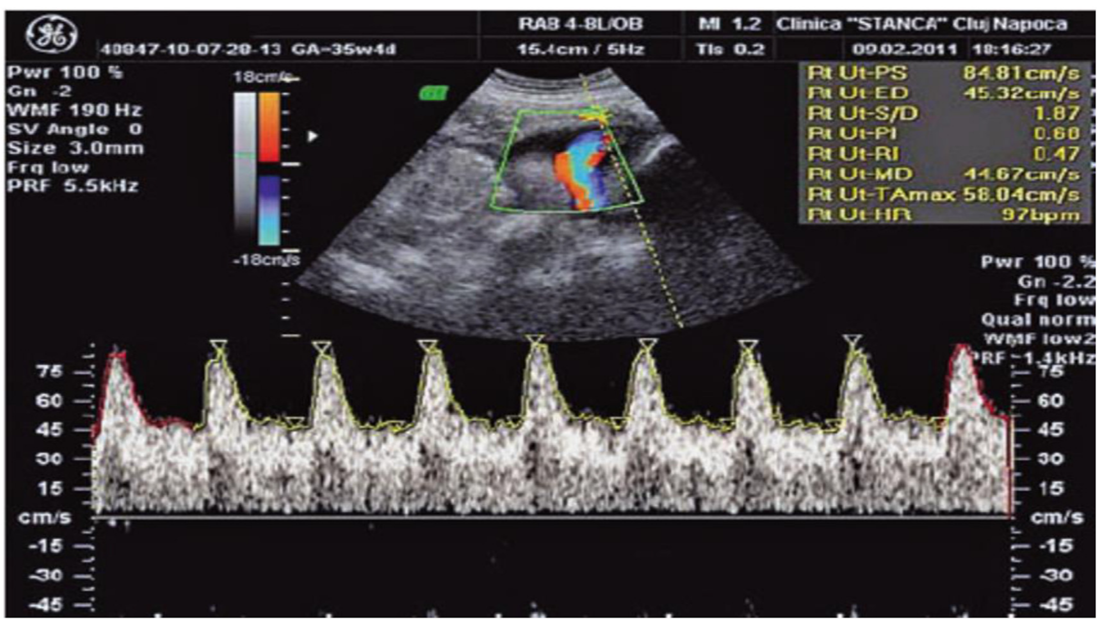

Fig. 2. Normal pulsed and color Doppler of uterine artery (37 WG).

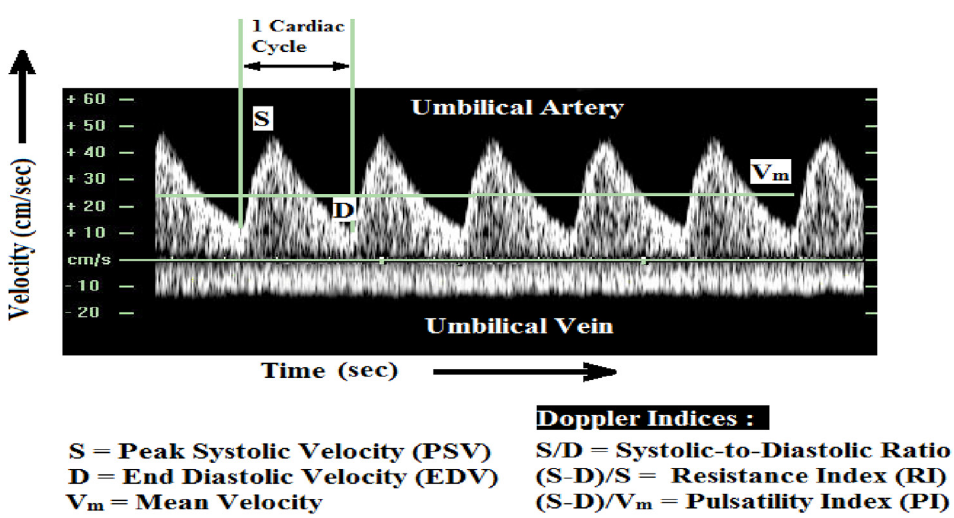

Fig. 3. Doppler velocimetry of umbilical artery and Doppler indices.

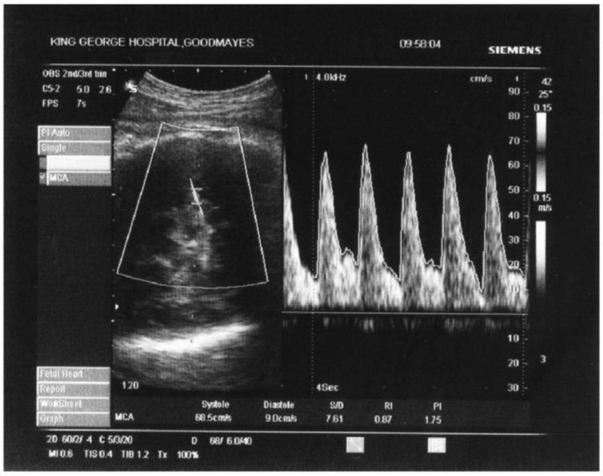

Fig. 4. Doppler imaging of the middle cerebral artery.

RDs, aspiration of meconium, IUGR, intrauterine fetal death (IUFD) and APGAR score less than 8 at 5 min. Maternal outcome: (Development of complications) as: Eclampsia, cerebral hemorrhage, renal failure and HELLP syndrome.

2.6. Statistical analysis

SPSS (Statistical Package for Social Sciences) version 22 for Windows was utilized to code, process, and analyze the obtained data (IBM SPSS Inc, Chicago, IL, USA). The Shapiro Walk test was used to determine whether the data had a normally distributed. Frequencies and relative proportions were utilized to depict qualitative data. As shown, the χ^2 test was employed to quantify the variance between qualitative variables. The mean ± SD (Standard deviation) of quantitative data was utilized. To compare two independent groups of normally distributed data, the independent samples *t*-test was utilized (parametric data).

3. Results

There are two groups; cases $n = 50$ and controls $n = 50$ participants. The mean age among the cases is 30.5 ± 8.1 compared with 35.2 ± 4.9 among controls and no statistically substantial variation among two groups according age. Regarding residence 70% rural and 30% urban among cases compared with 39% rural and 22% urban among controls. There is no statistical substantial variation in residency between the two groups. The mean BMI is 34.5 ± 3.7 and 33.1 ± 2.1 among cases and controls with no statistically substantial variation among two groups regarding BMI Table 1.

Table 1. Demographic data of the participants (N = 68).

Variables	Cases	Controls	*P* value
Age (years)			
Mean ± SD	30.5 ± 8.1	35.2 ± 4.9	0.235[a]
Range	20 (20, 40)	22 (18, 40)	
Residence			
Rural *n* (%)	35 (70)	39 (78)	0.108[b]
Urban *n* (%)	15 (30)	11 (22)	
BMI			
Mean ± SD	34.5 ± 3.7	33.1 ± 2.1	0.244[a]

SD, standard deviation.
P is significant at <0.05.
[a] Student *t*-test.
[b] χ^2 chi square test.

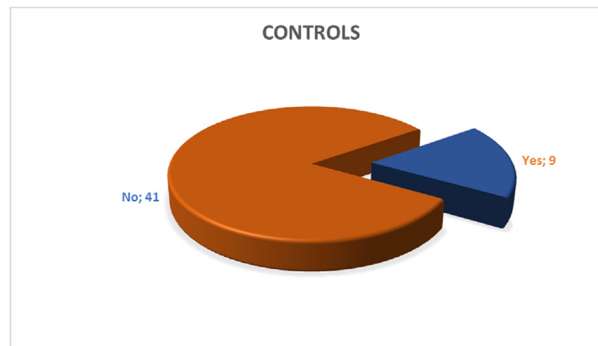

Fig. 5. History of past preeclampsia among the two groups.

There is 22% and 18% had previous history of preeclampsia among cases and controls. Fig. (5).

There is statistically significant difference between cases and controls regarding umbilical artery indices by Doppler ultrasound (PI, RI, S/D) Table 2.

There is statistically significant difference between cases and controls regarding middle cerebral artery indices by Doppler ultrasound (PI, RI, S/D) Table 3.

There is statistically substantial variation among cases and controls regarding maternal complications as eclampsia, cerebral hemorrhage, renal failure and HELLP syndrome Table 4.

4. Discussion

In underdeveloped nations, pregnancy-induced hypertension is one of the leading reasons of

Table 2. Comparison of umbilical artery between two groups.

Indices	Cases	Controls	*P* value
PI	0.810 ± 0.111	1.158 ± 0.237	<0.001*
RI	0.561 ± 0.052	0.629 ± 0.082	0.002*
S/D	2.253 ± 0.229	2.685 ± 0.513	0.005*

Quantitative data represented as mean ± SD.
Student t test to assess difference.
P is significant at <0.05, PI: Pulsality index, RI: Resistive index.
S/D: Systolic diastolic ratio.

Table 3. Comparison of middle cerebral artery between two groups.

Complications	Cases	Controls	*P* value
Eclampsia			
No	43 (86)	50 (100)	**<0.001***
Yes	7 (14)	0	
Cerebral hemorrhage			
No	48 (96)	49 (98)	**0.006***
Yes	2 (4)	1 (2)	
Renal failure			
No	45 (90)	48 (96)	0.016*
Yes	5 (10)	2 (4)	
HELLP			
No	31 (62)	46 (92)	
Deranged LFT	6 (12)	3 (6)	<0.001*
Thrombocytopenia	4 (8)	1 (2)	
Complete HELLP	9 (18)	0	

χ^2Chi square test.
P is significant at <0.05.

Table 4. Comparison of maternal complications among two groups.

Complications	Cases	Controls	*P* value
NICU admission			
No	26 (52)	42 (84)	<0.001*
Yes	24 (48)	8 (16)	
RDS			
No	43 (86)	47 (94)	<0.001*
Yes	7 (14)	3 (6)	
IUGR			
No	45 (90)	49 (98)	0.009*
Yes	5 (10)	1 (2)	
IUFD			
No	42 (84)	47 (94)	0.005*
Yes	8 (16)	3 (6)	
5-min APGAR <8			
No	46 (92)	49 (98)	0.039*
Yes	4 (8)	1 (2)	

IUFD, intrauterine fetal death; IUGR, intrauterine growth retardation; NICU, newborn intensive care unit; RDS, Respiratory distress syndrome.
χ^2 Chi square test.
P is significant at <0.05.

maternal and perinatal illness and death. Because it causes aberrant placentation, which includes abnormal trophoblast invasion of spiral arteries, the uteroplacental circulation's vascular resistance increases. In the absence of proper treatment, this process may result in IUGR Raguema and colleagues.[8]

This was case-control research that took place at AL-Azhar University Hospitals' Department of Gynecology and Obstetrics from April to December 2021.

Cases were subdivided in to two groups (50 patients each): group 1: 50 pregnant women with severe preeclampsia at or after 34 weeks of pregnancy and group 2: 50 normal pregnant women at or after the 34th week of gestation.

There is no statistically substantial variation among two groups according Demographic data of the participants. There is also no statistically substantial variation among two groups regarding Obstetric characteristics of the participants. Similar data were found in Shaheen and colleagues.[9]

There 30 and 20% had previous abortion among cases and controls, respectively. Similar findings were in Bhattacharya and colleagues[10] there 35 and 22% had previous abortion among cases and controls, respectively.

In terms of systolic and diastolic blood pressure, there is a statistically substantial variation in the two groups. In terms of other factors, there is no statistically substantial variation in the two groups. Along with our results Redman and colleagues[11] Although substantial changes in blood pressure were found in the group of women who went on to develop preeclampsia, such a prediction had to be confirmed in individual individuals. Clinical signs that can be used to detect people who will get preeclampsia earlier in gestation have yet to be discovered.

In our research there is statistically substantial variation in cases and controls regarding umbilical artery indices by Doppler ultrasound (PI, RI, S/D).

Audette and Kingdom,[12] reported that Conditions like PIH and FGR, which produce chronic placental inadequacy, are typical reasons of elevated risk for both mother and baby. Extremely high prenatal blood pressure, vision disturbances, seizures, growth retardation, preterm, insufficient liquid amnii, unintentional bleeding, and traumatic delivery are all factors that lead to a high rate of perinatal and maternal morbidity and death.

In Gupta and colleagues[13] investigations, in the case group, the mean S/D ratio, PI, and RI of the umbilical artery all decreased substantially. In the umbilical artery, the mean SD ratio, PI, and RI were similar in both groups. There was a substantial variation in ($P = 0.001$). However, there was no substantial variation in SD ratio or PI between groups 1 and 2.

Dasgupta and colleagues[14] found that after 10 min, the umbilical artery S/D ratio had fallen by 17 percent from baseline; after 20 min, the average decrease was 21 percent ($P < 0.006$).

In our research there is statistically substantial variation between cases and controls regarding MCA indices by Doppler ultrasound (PI, RI, S/D).

Along with our results Rani and colleagues[15] showed that in preeclampsia, the MCA and UA Doppler indices are markedly aberrant, although diagnostic statistical analysis shows that they have strong specificity but limited sensitivity for predicting unfavourable perinatal outcomes. Furthermore, for detecting unfavourable perinatal outcomes, the MCA/UA PI ratio (CPR) and MCA/UA RI ratio showed sensitivity of 9% and 9.7%, respectively, and specificity of 98 and 96.6%.

Maged and colleagues[16] also showed that when compared with women who had a normal perinatal result, those who had a worse neonatal result had a greater UA-PI (0.89 vs. 0.72), a lower MCA-PI (0.92 vs. 1.29), and a lower CPR (1.04 vs. 1.83).

In our research there is statistically substantial variation in cases and controls regarding maternal complications as eclampsia, cerebral hemorrhage, renal failure and HELLP syndrome.

In our research there is statistically substantial variation in cases and controls regarding fetus complications as NICU admission, RDS, IUGR, IUFD and 5 min APGAR score less than 8.

Along with our results Shaheen and colleagues[9] study revealed that, there was no statistically substantial variation in the two groups as regard maternal age. This is comparable with the study done by Adekanmi and colleagues,[17] who also found that there was no substantial age distinction between the two groups ($P = 0.936$). Pregnant women who acquired preeclampsia (PE) had an average age of 32.03 ± 4.11 years with a ranging of 22−39 years, whereas pregnant women who did not acquire PE had an average age of 31.65 ± 6.42 years with a ranging of 15−48 years.

Also, the results were close to that done by Raj and Sheela[18] who found the average age was 25.13 ± 4.33 years, with a minimum of 18 years and a maximum of 36 years.

The findings of this investigation differed from those of Liu and colleagues[19] who reported the age of the eclampsia patients and controls indicated a substantial variance. The discrepancy might be related to the patient selection criteria used in their research for preeclampsia patient's versus PE cases in the current research.

El-Sherbiny and Kamal,[20] showed Pregnant women with preeclampsia (moderate and extreme preeclampsia) and their matched control group had no substantial variation in hemoglobin levels or haematocrit values.

While a study's findings done by El-garhey and colleagues[21] found no statistically significant difference according to HB level and platelet count when preeclamptic patients were compared with controls.

Also, in the study done by Makuyana and colleagues[22] they found no difference in PLTs count between preeclamptic and controls.

In addition, El-garhey and colleagues[21] found that there was a decrease in platelet count throughout the normal pregnancy reaching 30 weeks and suggested that the decrease was due to plasma dilution and increased consumption the study showed a significant increase among patients' group than controls as regard systolic and diastolic pressures. This was consistent with Eser and colleagues.[23]

Also, with Liu and colleagues[19] report in which there was a substantial difference in systolic and diastolic blood pressure between preeclampsia patients and controls. From the present research findings, there was a statistically substantial increase among patients than controls regarding Doppler indices of UA and UTA (RI and PI).

In comparison to, Lopez-Mendez and colleagues[5] it was observed that there was no substantial distinction in uterine artery PI and RI among women with PE and those without PE, but there was a substantial distinction in umbilical artery PI and RI among women with PE and those without PE, which is similar to our results in the current research in the umbilical arteries.

This investigation revealed that, there was a statistically substantial reduction in Doppler MCA (S/D, RI and PI) among patients' group than controls. In accordance with Özeren et al., 1999 who showed that MCA-PI value was lower in the preeclamptic groups.

Also, Abdelrazik and colleagues[7] found that the fetuses that had a poor result showed a lower PI index in the middle cerebral artery, confirming the findings of Brar et al., and Arduini and Rizzo.

This study revealed that, MCA/UA PI and MCA/UAT PI ratio was significantly decreased among preeclamptic than the control group. This agreed with Ghosh and colleagues[24] revealed that the MCA PI/UA PI ratio was 1, which was statistically relevant ($P < 0.05$) in 25.5% of instances of unfavourable pregnancy outcomes and absent in 17.3%.

Also Shahinaj and colleagues[25] the MCA/UA PI ratio was shown to have a significant sensitivity in predicting stillbirth (100%). They also discovered that the requirement for treatment in the newborn critical care unit had a good specificity and positive predictive value. When comparing the MCA, UA, and RA PI indices, the author discovered that the UA/MCA PI index ratio was the best test (sensitivity 89%, specificity 94%).

The MCA/UA PI Doppler ratio of less than one was shown to be an excellent predictor of pregnancy outcomes in preeclamptic and hypertensive pregnant women, and might be utilized to detect fetuses at risk of morbidity and death.

According to the findings of this research, there was a statistically substantial variation in Apgar score in the first 5 min of fetal outcome between patients and controls. Patients had a lower Apgar score than controls, and the majority of them were admitted to the NICU.

This is consistent with Ayaz and colleagues[26] who demonstrated that, low Apgar score was seen in cases as compared with controls and there was high need for NICU admission (26.02%) in cases compared with controls (9.5%).

Abdelrazik and colleagues[7] also revealed that the group of MCA/UA PI ratio less than 1 was significantly associated with 5 min Apgar score less than 7. The result of this study is comparable to those of El-Sokkary and colleagues[27] which found that the rate Apgar score less than 1.

Additionally, Yalti and colleagues[28] revealed that a fetus with abnormal Doppler velocimetry was more likely to be admitted to the NICU. According to the findings of the present research, there was a statistically substantial rise in patients in terms of method of delivery, presence of IUGR, and complications.

Most patients had C.S, higher IUGR and complications. This is comparable with results of the study done by Abdelrazik and colleagues[7] which found that IUGR was significantly higher than controls. Different postnatal complications were found in babies of complicated case with jaundice, sepsis, need for antibiotics and hypoglycemia.

Also, in a study done by Shwarzman and colleagues[29] In a prospective study to assess the relationship between abnormal uterine artery resistance in the third trimester of gestation and birth outcomes, it was discovered that infants born to women with bilateral pathologic uterine artery Doppler waveforms had a greater rate of cesarean section and preterm deliveries, small-for-gestationalage neonates, and reduced Apgar scores than those born to women with normal or pathologic unilateral waveforms.

Thus, they came to the conclusion that anomalies in uterine artery Doppler velocimetry found in the late third trimester are a strong predictor of poor pregnancy outcome in both low and high-risk pregnancies. In the study that was done by Ayaz and colleagues[26] it was found that IUGR was significantly present in cases.

4.1. Conclusion

There is a strong correlation between the MCA/UA (PI) and MCA/UT (PI) ratio and neonatal outcome; it was revealed that a normal MCA/UA (PI) and MCA/uterine (PI) ratio is a strong predictive of a normal fetal outcome, while an abnormal value is strongly associated with neonatal morbidity.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article.

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Conflicts of Interest

There are no conflicts of interest.

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