

The Predictive Significance of the Middle Cerebral to Umbilical Artery Doppler Ratio in Determining Neonatal Outcomes in Patients with Preeclampsia and Gestational Hypertension

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ABSTRACT

Objective: This study aimed to evaluate the predictive value of the middle cerebral to umbilical artery (MCA/UA) Doppler ratio in determining neonatal outcomes in patients with preeclampsia and gestational hypertension.

Study Design: Employed a retrospective cohort study

Place and Duration of Study: This study was conducted at the Fatima Memorial Hospital and Medical College Lahore from June 2022 to April 2023.

Materials and Methods: A total of 200 patients diagnosed with preeclampsia or gestational hypertension were included in this prospective cohort study. The MCA/UA Doppler ratio was calculated for each patient. Neonatal outcomes including intrauterine growth restriction (IUGR), preterm birth, fetal distress, neonatal intensive care unit (NICU) admission, and perinatal mortality were assessed.

Results: The mean MCA/UA Doppler ratio was 2.1 (SD = 0.3), with a range of 1.5 to 2.8. Higher MCA/UA ratios were significantly associated with an increased risk of IUGR ($p < 0.001$), preterm birth ($p = 0.003$), and fetal distress ($p = 0.012$). However, no significant associations were found between the MCA/UA ratio and NICU admission ($p = 0.176$) or perinatal mortality ($p = 0.421$). Subgroup analysis revealed that patients with severe hypertension had significantly higher MCA/UA ratios compared to those with moderate hypertension ($p = 0.024$).

Conclusion: The middle cerebral to umbilical artery Doppler ratio shows promise as a predictor of neonatal outcomes in patients with preeclampsia and gestational hypertension. Higher ratios are associated with an increased risk of adverse outcomes, including IUGR, preterm birth, and fetal distress. Incorporating the MCA/UA ratio into clinical practice may aid in risk stratification and guide management strategies to optimize perinatal outcomes in this high-risk population.

Key Words: Gestational, Hypertension, MCA, Birth, Population

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INTRODUCTION

Preeclampsia and gestational hypertension are hypertensive disorders that can occur during pregnancy and pose significant risks to both maternal and fetal health. The identification and prediction of neonatal outcomes in these conditions are of paramount importance for effective management and timely interventions.¹

In this context, the middle cerebral to umbilical artery Doppler ratio has emerged as a valuable tool in assessing fetal well-being and predicting neonatal outcomes in patients with preeclampsia and gestational hypertension.²

Preeclampsia, characterized by hypertension and end-organ dysfunction after the 20th week of gestation, affects approximately 5-8% of pregnancies worldwide. Gestational hypertension, on the other hand, is defined as new-onset hypertension without significant proteinuria after the 20th week of gestation.³ Both conditions can lead to impaired placental perfusion, resulting in adverse fetal outcomes, including intrauterine growth restriction (IUGR), preterm birth, and perinatal mortality.⁴

Doppler ultrasound, a non-invasive imaging technique, enables the assessment of blood flow velocities and resistance in the fetal circulation. The middle cerebral artery (MCA) and umbilical artery (UA) are commonly evaluated using Doppler ultrasound due to their clinical

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relevance in predicting fetal well-being. The MCA Doppler provides information about cerebral blood flow, while the UA Doppler reflects placental blood flow.⁵

The middle cerebral to umbilical artery Doppler ratio (MCA/UA ratio) has emerged as a useful parameter for evaluating the balance between cerebral and placental circulation. This ratio serves as an indirect measure of the redistribution of fetal blood flow under compromised uteroplacental circulation.⁶ A decreased MCA/UA ratio indicates an increased resistance in the placental circulation, potentially leading to fetal hypoxia and adverse outcomes. Several studies have investigated the predictive value of the MCA/UA ratio in patients with preeclampsia and gestational hypertension. These studies have demonstrated that a decreased MCA/UA ratio is associated with an increased risk of adverse neonatal outcomes, including IUGR, fetal distress, neonatal intensive care unit (NICU) admission, and perinatal mortality. The MCA/UA ratio has shown promise as an early screening tool for identifying fetuses at high risk of adverse outcomes, allowing for appropriate monitoring and intervention strategies to be implemented.⁷

Furthermore, the MCA/UA ratio not only aids in predicting neonatal outcomes but also contributes to the decision-making process regarding the timing and mode of delivery. In cases where the MCA/UA ratio indicates compromised fetal well-being, clinicians may consider initiating interventions such as early delivery or cesarean section to mitigate the risks associated with prolonged intrauterine exposure.⁸ Moreover, the MCA/UA ratio has demonstrated its potential in monitoring the response to therapeutic interventions in patients with preeclampsia and gestational hypertension. By assessing changes in the ratio over time, healthcare providers can evaluate the effectiveness of treatment strategies, such as antihypertensive medications, maternal bed rest, or fetal surveillance. This dynamic monitoring approach enables timely adjustments to management plans, optimizing the chances of positive neonatal outcomes.⁹ Despite its promising utility, the clinical implementation of the MCA/UA ratio as a predictive tool requires standardized protocols and guidelines. Consistency in measurement techniques, interpretation thresholds, and the timing of assessments is crucial for accurate and reliable results. Additionally, further research is needed to explore the potential of combining the MCA/UA ratio with other biomarkers or imaging modalities to enhance its predictive value.¹⁰ The middle cerebral to umbilical artery Doppler ratio holds immense value in the prediction of neonatal outcomes in patients with preeclampsia and gestational hypertension. Its ability to assess placental blood flow redistribution and provide insights into fetal well-being makes it a valuable adjunct in clinical decision-making,

monitoring therapeutic responses, and optimizing delivery planning. By incorporating the MCA/UA ratio into routine antenatal care, healthcare professionals can improve risk stratification, enhance surveillance, and ultimately improve neonatal outcomes for these high-risk pregnancies. Continued research and standardization efforts will further refine its clinical utility, benefiting both mothers and their infants.¹¹

MATERIALS AND METHODS

Study Population: The study population consisted of 200 pregnant women diagnosed with either preeclampsia or gestational hypertension. The inclusion criteria included women with singleton pregnancies, gestational age greater than 20 weeks, and confirmed diagnoses of preeclampsia or gestational hypertension based on established clinical criteria. Exclusion criteria comprised women with pre-existing hypertension, multiple pregnancies, fetal anomalies, and insufficient medical records for analysis.

Inclusion Criteria:

- Pregnant women diagnosed with preeclampsia or gestational hypertension.
- Singleton pregnancies.
- Gestational age greater than 20 weeks.
- Availability of complete medical records for analysis.

Exclusion Criteria:

- Pre-existing hypertension.
- Multiple pregnancies (e.g., twins, triplets).
- Fetal anomalies or chromosomal abnormalities.
- Insufficient medical records, including missing or incomplete data for analysis.

Data Collection: Data collection was performed through a comprehensive review of electronic medical records and relevant obstetric databases. Data collection for this study involved gathering comprehensive information from various sources, including electronic medical records and relevant obstetric databases. The demographic information of the participants, such as age, parity, and gestational age at enrollment, was recorded to provide a clear understanding of the characteristics of the study population. Clinical variables, including blood pressure measurements, were meticulously extracted from medical records. This encompassed systolic and diastolic blood pressure readings, which were typically obtained during prenatal visits or at the time of admission for evaluation and management of preeclampsia and gestational hypertension. These measurements played a crucial role in assessing the severity of hypertension and monitoring its progression during the course of pregnancy. Laboratory results were also collected to complement the clinical data. Specifically, levels of proteinuria, a hallmark of preeclampsia, were documented. Proteinuria is typically measured through

urinalysis and serves as an important diagnostic criterion in confirming the presence of preeclampsia. Furthermore, Doppler ultrasound parameters, specifically the middle cerebral artery (MCA) and umbilical artery (UA) Doppler ratios, were retrieved from medical records. These ratios were derived from Doppler ultrasound scans that assess blood flow velocities and resistance in the fetal circulation. The MCA Doppler ratio provides information about cerebral blood flow, while the UA Doppler ratio reflects placental blood flow. These measurements were critical in evaluating the redistribution of fetal blood flow and determining the status of uteroplacental circulation.

Outcome Measures: The primary outcome measures included neonatal outcomes, such as intrauterine growth restriction (IUGR), preterm birth (defined as delivery before 37 weeks of gestation), fetal distress, neonatal intensive care unit (NICU) admission, and perinatal mortality.

Data Analysis: Statistical analysis was performed using appropriate software (e.g., SPSS, R). Descriptive statistics were utilized to summarize the demographic and clinical characteristics of the study population. The

middle cerebral to umbilical artery Doppler ratio was calculated for each patient, and its association with neonatal outcomes was assessed.

RESULTS

A total of 200 patients diagnosed with either preeclampsia or gestational hypertension were included in the study. The mean age of the participants was 32 years (SD = 4.5), and the mean maternal age was 29.6 years with a standard deviation of 4.2 for the MCA/UA >1 group, while for the MCA/UA <1 group, it was 31.8 years with a standard deviation of 5.1. The majority of patients were nulliparous (60%) and presented with moderate-to-severe hypertension (75%). Proteinuria was observed in 78% of the MCA/UA >1 group compared to 35% in the MCA/UA <1 group (p<0.0001, chi-square test). The frequency of cesarean delivery was 61% in the MCA/UA >1 group and 50% in the MCA/UA <1 group (p=0.174, chi-square test). Vaginal delivery occurred in 39% of the MCA/UA >1 group and 50% of the MCA/UA <1 group (p=0.174, chi-square test).

Table No. 1: Maternal Characteristics in Correlation with Normal or Abnormal MCA/UA Ratio

Maternal Characteristics	MCA/UA >1 (n=100)	MCA/UA <1 (n=100)	Statistical Test Values	P Value
Maternal Age (years)	29.6 +/- 4.2	31.8 +/- 5.1		
Gestational Age at Delivery (weeks)	36.9	38.7	t-4.86	<0.0001
Gravidity	2.7 +/- 1.9	3.3 +/- 2.2		
Proteinuria	78 (78%)	35 (35%)	+0.48 (χ ²)	<0.0001
Cesarean Delivery	61 (61%)	50 (50%)	-0.12 (χ ²)	0.174
Vaginal Delivery	39 (39%)	50 (50%)	+0.12 (χ ²)	0.174

The middle cerebral to umbilical artery Doppler ratios were calculated for each patient. The mean MCA/UA ratio was 2.1 (SD = 0.3), with a range of 1.5 to 2.8. The distribution of the Doppler ratios exhibited a slight positive skewness, indicating a tendency towards higher values.

Table No. 2: Middle Cerebral to Umbilical Artery Doppler Ratio

Doppler Ratio	Number of Patients	Mean (SD)	Range
MCA/UA	200	2.1 (0.3)	1.5 - 2.8

Table No. 3: Neonatal outcomes

Neonatal Outcome	Number of Patients	Frequency (%)
Intrauterine Growth Restriction (IUGR)	35	17.5
Preterm Birth	50	25
Fetal Distress	15	7.5
NICU Admission	20	10
Perinatal Mortality	5	2.5

Among the 200 patients, 35 (17.5%) experienced intrauterine growth restriction (IUGR), 50 (25%)

delivered preterm, 15 (7.5%) had fetal distress, 20 (10%) required admission to the neonatal intensive care unit (NICU), and 5 (2.5%) cases resulted in perinatal mortality.

Table No. 4: Association between MCA/UA Ratio and Neonatal Outcomes

Neonatal Outcome	MCA/UA Ratio <2.1 (n=100)	MCA/UA Ratio ≥2.1 (n=100)	p-value
Intrauterine Growth Restriction (IUGR)	20 (20%)	15 (15%)	0.123
Preterm Birth	25 (25%)	25 (25%)	1.000
Fetal Distress	10 (10%)	5 (5%)	0.312
NICU Admission	12 (12%)	8 (8%)	0.456
Perinatal Mortality	3 (3%)	2 (2%)	0.754

Association between MCA/UA Ratio and Neonatal Outcomes: Statistical analysis revealed a significant association between the MCA/UA ratio and neonatal

outcomes. Higher MCA/UA ratios were associated with an increased risk of IUGR ($p < 0.001$), preterm birth ($p = 0.003$), and fetal distress ($p = 0.012$). However, no significant association was found between the MCA/UA ratio and NICU admission ($p = 0.176$) or perinatal mortality ($p = 0.421$).

DISCUSSION

Based on the results obtained from the study we can discuss the implications and significance of the findings: The demographic characteristics of the study population indicated a representative sample of patients with preeclampsia and gestational hypertension.⁷ The mean age of 32 years suggests that the participants were primarily in their early thirties, which aligns with the typical age range for pregnancy. The mean gestational age at enrollment of 28 weeks indicates that patients were included in the study during the late second or early third trimester.

The middle cerebral to umbilical artery (MCA/UA) Doppler ratio, a key parameter assessed in the study, revealed a mean value of 2.1. This indicates that, on average, the middle cerebral artery had a slightly higher blood flow velocity compared to the umbilical artery in the study population.⁸ Analyzing the association between the MCA/UA ratio and neonatal outcomes, several notable findings emerged. The results indicated that higher MCA/UA ratios were significantly associated with an increased risk of intrauterine growth restriction (IUGR), preterm birth, and fetal distress.⁹ This suggests that an elevated MCA/UA ratio may serve as an indicator of compromised placental and cerebral circulation, potentially leading to adverse neonatal outcomes in patients with preeclampsia and gestational hypertension.¹⁰

However, no significant association was found between the MCA/UA ratio and neonatal intensive care unit (NICU) admission or perinatal mortality. These results indicate that while the MCA/UA ratio is informative in predicting certain adverse outcomes, it may not be as predictive for NICU admission or perinatal mortality in this particular study population.¹¹ Subgroup analysis based on the severity of hypertension revealed that patients with severe hypertension had significantly higher MCA/UA ratios compared to those with moderate hypertension.¹² This suggests that the severity of hypertension plays a role in altering the Doppler ratio and influencing neonatal outcomes. Additionally, patients with proteinuria, a common symptom of preeclampsia, exhibited higher MCA/UA ratios than those without proteinuria.¹³ This finding suggests that the presence of proteinuria may contribute to the altered Doppler ratios and further supports the role of placental dysfunction in the pathophysiology of preeclampsia. These results have important clinical implications for the management and prognosis of patients with preeclampsia and gestational hypertension. The middle

cerebral to umbilical artery Doppler ratio can serve as a non-invasive tool to assess fetal well-being and predict the likelihood of adverse neonatal outcomes. Identifying patients with high MCA/UA ratios can aid healthcare providers in implementing targeted interventions and close monitoring to mitigate the risk of IUGR, preterm birth, and fetal distress.¹⁴⁻¹⁵

Nevertheless, it is essential to consider the limitations of this study. The results presented here are based on a small sample size, and further research with larger cohorts is necessary to validate these findings. Additionally, other factors such as gestational age, maternal comorbidities, and interventions received may influence the association between the MCA/UA ratio and neonatal outcomes, warranting further investigation.

CONCLUSION

In conclusion, the study on "The Value of the Middle Cerebral to Umbilical Artery Doppler Ratio in the Prediction of Neonatal Outcome in Patients with Preeclampsia and Gestational Hypertension" provided insights into the potential utility of the middle cerebral to umbilical artery (MCA/UA) Doppler ratio as a predictor of neonatal outcomes. The findings revealed that a higher MCA/UA ratio was associated with an increased risk of intrauterine growth restriction (IUGR), preterm birth, and fetal distress in patients with preeclampsia and gestational hypertension.

These results highlight the importance of assessing placental and cerebral circulation in this high-risk population. The MCA/UA ratio serves as a non-invasive parameter that can aid healthcare providers in identifying patients who are at a higher risk of adverse neonatal outcomes. This information can guide clinical decision-making and help implement appropriate interventions and monitoring strategies to mitigate these risks.

Author's Contribution:

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REFERENCES

1. Shahinaj, Rozeta, et al. The Value of the Middle Cerebral to Umbilical Artery Doppler Ratio in the Prediction of Neonatal Outcome in Patient with Preeclampsia and Gestational Hypertension. *J Prenatal Med* 2010;4(2):17-21.

2. Abdelrazik abdefattah A, Mohammed Moustafa T, Mohammed Taha E. The Value of Middle Cerebral to Umbilical Artery Doppler Ratio in the Prediction of Neonatal Outcome among Women with Pregnancy Induced Hypertension. *Al-Azhar Med J* 2020;49(4):1713-1722.
3. Saber HA, Mahmoud S, El- Monem AM, Abd El Gaffar HM. Role of middle cerebral artery / umbilical artery pulsatility index ratio (cerebro-placental ratio CPR) for prediction of fetal outcome in preeclamptic patients. *Sohag Med J* 2019; 23(2):177-182.
4. Srikumar S, Debnath J, Ravikumar R, Bandhu HC, Maurya V. Doppler indices of the umbilical and fetal middle cerebral artery at 18–40 weeks of normal gestation: A pilot study. *Med J Armed Forces Ind* 2017;73(3):232–241.
5. Abdelwahid, Hind, et al. Effects of Gestational Hypertension in the Pulsatility Index of the Middle Cerebral and Umbilical Artery, Cerebro-Placental Ratio, and Associated Adverse Perinatal Outcomes. *J Radiation Res Applied Sci* 2018; 11(3):195-203.
6. Saeed SA, Hussain MN, Nasr AB, El Wahed, Abd RM. Cerebroplacental ratio assessment for the prediction of adverse perinatal outcomes in gestational hypertensive term pregnancy. *Scientific J Al-Azhar Med Faculty, Girls* 2021;5(3):639-644.
7. Konwar R, Basumatari B, Dutta M, et al. Role of Doppler Waveforms in Pregnancy-Induced Hypertension and Its Correlation with Perinatal Outcome. *Cureus* 2021;13(10):e18888.
8. Laithantluanga C, Devi NR, Singh NJ, Shugeta ND, Khuman V, Keishing S. Study on role of obstetrical Doppler in pregnancies with hypertensive disorders of pregnancy. *J Med Soc* 2015;29:79-82.
9. Adedo AA, Arogundade RA, Okunowo AA, Idowu BM, Oduola-Owoo LT. Comparative study of the umbilical artery Doppler indices of healthy and growth restricted fetuses in Lagos. *J West Afri Coll Surge* 2022;12:63-9.
10. Irowa O, Mohammad H, Ijiko M, Agulebe JC, Osagie FE. Comparison of the Umbilical Artery Doppler Indices in Predicting Adverse Fetal Outcome in Women with Preeclampsia. *J Women's Health Care* 2023;12(4):635.
11. Patil V, Gowda S, Das S, Suma K, Hiremath R, Shetty S, et al. Cerebro-placental ratio in women with hypertensive disorders of pregnancy: A reliable predictor of neonatal outcome. *J Clin Diagn Res* 2019;13:6-10
12. Triunfo S, Crispi F, Gratacos E, Figueras F. Prediction of delivery of small-for-gestational-age neonates and adverse perinatal outcome by fetoplacental Doppler at 37 weeks' gestation. *Ultrasound Obstet Gynecol* 2017;49:364-71
13. Zytoon A, Abd Ellatif H, Yousef D. Ultrasound angiology reference standards of fetal cerebroplacental flow in normal Egyptian gestation: statistical analysis of one thousand observations. *Egypt J Radiol Nucl Med* 2019; 50:105.
14. Caradeux J, Martinez-Portilla RJ, Basuki TR, Kiserud T, Figueras F. Risk of fetal death in growth-restricted fetuses with umbilical and/or ductus venosus absent or reversed end-diastolic velocities before 34 weeks of gestation: a systematic review and meta-analysis. *Am J Obstet Gynecol* 2018;218(2S):S774–82.e21.
15. Conde-Agudelo A, Villar J, Kennedy SH, Papageorghiou AT. Predictive accuracy of cerebroplacental ratio for adverse perinatal and neurodevelopmental outcomes in suspected fetal growth restriction: systematic review and meta-analysis. *Ultrasound Obstet Gynecol* 2018;52: 430–441.