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Research Article

The Predictive Value of Mca/Ua Pulsatility Index Ratio in Adverse Perinatal Outcomes among Women with Preeclampsia and Gestational Hypertension

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ABSTRACT
Background: Preeclampsia and gestational hypertension are significant causes of maternal and fetal morbidity and mortality worldwide. The middle cerebral artery to umbilical artery (MCA/UA) pulsatility index ratio has emerged as a potential predictor of adverse perinatal outcomes in these conditions.
Methods: A prospective observational case-control study was conducted on 200 pregnant women diagnosed with preeclampsia or gestational hypertension after 30 weeks of gestation. Doppler ultrasound was used to measure the MCA/UA pulsatility index ratio. Women with a ratio ≤1 were categorized as cases, and those with a ratio >1 as controls. Adverse perinatal outcomes were recorded and analyzed.
Results: Of the 200 women, 52 (26%) had an MCA/UA ratio ≤1. The cases showed a significantly higher incidence of severe oligohydramnios (26.9% vs. 6.7%, p<0.0001), emergency cesarean sections (71.15% vs. 37.16%, p=0.00027), low birth weight (<2.5 kg) infants (59.61% vs. 25.67%, p<0.00001), and NICU admissions (68.62% vs. 30.55%, p<0.00001). The MCA/UA ratio demonstrated a sensitivity of 39.04% and specificity of 88.40% in predicting adverse perinatal outcomes.
Conclusion: An abnormal MCA/UA pulsatility index ratio (≤1) is significantly associated with adverse perinatal outcomes in women with preeclampsia and gestational hypertension. Routine use of this Doppler parameter can aid in early identification and management of at-risk pregnancies.

Keywords: Preeclampsia, Gestational Hypertension, MCA/UA Pulsatility Index Ratio, Adverse Perinatal Outcomes, Doppler Ultrasound.

INTRODUCTION

Preeclampsia affects 5-10% of pregnancies globally and remains a leading cause of maternal and fetal morbidity and mortality [1][2].

Despite extensive research, there is no definitive method for preventing preeclampsia. Consequently, routine antenatal care focuses on early identification of at-risk women to provide more intensive monitoring. Abnormal placentation characterizes preeclampsia, primarily due to inadequate trophoblastic invasion of maternal spiral arteries, leading to increased vascular resistance and decreased utero-placental perfusion. Doppler ultrasound velocimetry has become an established non-invasive method to assess fetal circulation and hemodynamics [3][4].

While the umbilical artery is commonly assessed, recent studies emphasize the significance of the middle cerebral artery (MCA) Doppler assessment [7][8]. The MCA/UA pulsatility index (PI) ratio reflects both placental insufficiency and fetal adaptive responses [13]. A ratio less than 1 indicates a redistribution of blood flow favoring the fetal brain, known as the "brain-sparing effect," which is associated with hypoxia and adverse perinatal outcomes [17][18].

This study aims to evaluate the predictive value of the MCA/UA PI ratio in adverse perinatal outcomes among women with preeclampsia and gestational hypertension.

MATERIALS AND METHODS

Study Design and Setting

A prospective observational analytical case-control study was conducted at the Muslim Maternity and Children's Hospital, Chaderghat, Hyderabad, from August 2013 to May 2015.

Study Population

The study included 200 antenatal women with singleton pregnancies diagnosed with preeclampsia or gestational hypertension after 30 weeks of gestation. The majority belonged to the middle and low socio-economic status and were from an urban background.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Singleton pregnancy
- Gestational age ≥30 weeks

- Diagnosed with gestational hypertension or preeclampsia

Exclusion Criteria
- Gestational age <30 weeks
- Multiple gestations
- Fetal congenital anomalies
- Chronic medical conditions (e.g., chronic hypertension, diabetes mellitus, renal disease)

Data Collection
After obtaining informed consent, participants underwent a detailed history and physical examination. Blood pressure measurements followed standard protocols. Doppler ultrasound was performed using the ALOKA SSD 630 with UGR 38 Doppler unit to measure the MCA and UA PI ratios.

Group Classification
Participants were categorized based on their MCA/UA PI ratio:
- **Cases:** MCA/UA PI ratio ≤1 (n=52)
- **Controls:** MCA/UA PI ratio >1 (n=148)

Outcome Measures
Adverse perinatal outcomes assessed included:
- Intrauterine and early neonatal death
- Fetal distress and meconium-stained liquor
- Mode of delivery
- Birth weight and intrauterine growth restriction (IUGR)
- Apgar score at 5 minutes
- NICU admissions

Statistical Analysis
Data were analyzed using SPSS version 15.0. Chi-square tests were used to assess associations between the MCA/UA PI ratio and perinatal outcomes. A p-value <0.05 was considered statistically significant.

RESULTS

Participant Characteristics
- **Age Distribution:** Majority were between 21-25 years (56.5%). No significant age difference between cases and controls (p=0.37).
- **Socio-Economic Status:** Predominantly middle class (73%). No significant difference between groups (p=0.68).
- **Parity:** Primigravida constituted 56% of the participants.

Doppler Findings
- **Gestational Age at Doppler:** Cases had Doppler assessments earlier than controls (p<0.0001).
- **UA PI Ratio:** Significantly higher in cases (p<0.0001).
- **MCA PI Ratio:** Significantly lower in cases (p<0.0001).
- **MCA/UA PI Ratio:** Mean ratio was 0.90 in cases and 1.83 in controls (p<0.00001).

Adverse Perinatal Outcomes
- **Oligohydramnios:** Severe oligohydramnios was more common in cases (26.9% vs. 6.7%, p<0.0001).
- **Mode of Delivery:** Higher rate of emergency cesarean sections in cases (71.15% vs. 37.16%, p=0.00027).
- **Birth Weight:** Cases had a higher incidence of low birth weight infants (<2.5 kg) (59.61% vs. 25.67%, p<0.00001).
- **Apgar Score:** More cases had Apgar scores <7 at 5 minutes (54.9% vs. 19.44%, p<0.00001).
- **NICU Admissions:** Higher in cases (68.62% vs. 30.55%, p<0.00001).

Predictive Value of MCA/UA PI Ratio
- **Sensitivity:** 39.04%
- **Specificity:** 88.40%
- **Positive Predictive Value (PPV):** 78.80%
- **Negative Predictive Value (NPV):** 56.70%

Table 1: Demographic Characteristics of Study Participants

Characteristic	Cases (n=52)	Controls (n=148)	Total (n=200)	p-value
Age (years)				0.370
≤20	12 (23%)	29 (19.6%)	41 (20.5%)	
21-25	28 (53.8%)	85 (57.4%)	113 (56.5%)	
26-30	11 (21.1%)	23 (15.5%)	34 (17%)	
31-35	0 (0%)	9 (6%)	9 (4.5%)	
>35	1 (1.9%)	2 (1.4%)	3 (1.5%)	
Socio-Economic Class				0.676
Lower	7 (13.4%)	21 (14.2%)	28 (14%)	
Middle	40 (76.9%)	106 (71.6%)	146 (73%)	
Upper	5 (9.6%)	21 (14.2%)	26 (13%)	

Table 2: Comparison of Doppler Parameters between Cases and Controls

Parameter	Cases (n=52)	Controls (n=148)	p-value
Gestational Age at Doppler (weeks)			<0.0001
30-34	13 (25%)	10 (6.7%)	
34-37	31 (59.6%)	78 (52.7%)	
>37	8 (15.4%)	60 (40.5%)	
Umbilical Artery PI (mean ± SD)	1.63 ± 0.28	1.04 ± 0.24	<0.0001
Middle Cerebral Artery PI (mean ± SD)	1.28 ± 0.15	1.73 ± 0.35	<0.0001
MCA/UA PI Ratio (mean ± SD)	0.90 ± 0.10	1.83 ± 0.48	<0.00001

Table 3: Adverse Perinatal Outcomes in Cases and Controls

Outcome	Cases (n=52)	Controls (n=148)	p-value
Severe Oligohydramnios	14 (26.9%)	10 (6.7%)	<0.0001
Emergency Cesarean Section	37 (71.2%)	55 (37.2%)	0.00027
Low Birth Weight (<2.5 kg)	31 (59.6%)	38 (25.7%)	<0.00001
Apgar Score <7 at 5 minutes	28 (54.9%)	28 (19.4%)	<0.00001
NICU Admissions	35 (68.6%)	44 (30.6%)	<0.00001

Table 4: Predictive Value of Mca/Ua Pi Ratio for Adverse Perinatal Outcomes

Parameter	Value
Sensitivity (%)	39.0
Specificity (%)	88.4
Positive Predictive Value (%)	78.8
Negative Predictive Value (%)	56.7
Positive Likelihood Ratio	3.73
Negative Likelihood Ratio	0.76

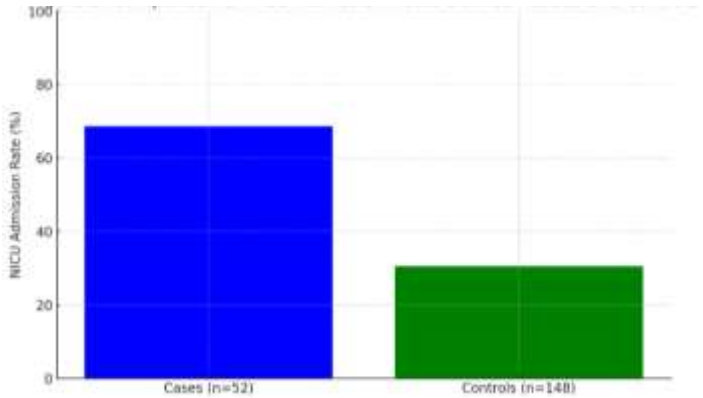

Figure 1: Comparison of Nicu Admission Rates between Cases and Controls

DISCUSSION

This study demonstrates that an abnormal MCA/UA PI ratio (≤1) is significantly associated with adverse perinatal outcomes in women with preeclampsia and gestational hypertension. The findings align with previous studies that reported the MCA/UA ratio as a reliable predictor of fetal compromise [13][14][15].

The cases had higher rates of severe oligohydramnios, emergency cesarean sections, low birth weight infants, and NICU admissions. These outcomes suggest that an abnormal MCA/UA PI ratio reflects both placental insufficiency and fetal adaptive mechanisms, such as the brain-sparing effect [17][18].

The sensitivity and specificity of the MCA/UA PI ratio in predicting adverse outcomes were comparable to earlier studies [16][19]. The high specificity (88.40%) indicates that a normal ratio effectively rules out the risk of adverse outcomes.

The study was hospital-based, which may limit the generalizability of the findings. The sample size, although adequate, was restricted due to time and resource constraints.

Incorporating MCA/UA PI ratio measurements into routine Doppler assessments for women

with preeclampsia and gestational hypertension can enhance the prediction of adverse perinatal outcomes. Early identification allows for timely interventions to improve fetal prognosis.

CONCLUSION

An MCA/UA PI ratio ≤1 is a significant predictor of adverse perinatal outcomes in preeclampsia and gestational hypertension. Routine Doppler assessment of this ratio can aid in the early detection and management of at-risk pregnancies, potentially reducing fetal morbidity and mortality.

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