

# Ultrasonic fetal Doppler and growth indices and their relation to immediate neonatal outcomes in different severities of maternal anemia

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## Keywords:

Ultrasonic fetal Doppler; growth indices; immediate neonatal outcomes; severities of maternal anemia

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## ABSTRACT

Doppler assessment may lead to intervention that reduces the risk of fetal brain damage. Aim of the study: to assess the relation between ultrasonic hemodynamic Doppler indices of middle cerebral and umbilical arteries (PI, RI), growth indices to immediate neonatal outcomes (weight, head & abdominal circumference, APGAR scores at 1 and 5 minutes and neonatal unit admission) in women with mild, moderate and severe anemia during pregnancy. Present study is a clinical prospective study carried out in Al-Elwiya Maternity Teaching Hospital during (January-June) 2019, all anemic pregnant women presented to Obstetrical wards in hospitals for emergency cesarean section were the study population. The final sample selected was 120 pregnant women. Ultrasound Doppler velocimetry measurements like middle cerebral artery-peak systolic velocity (MCA-PSV), middle cerebral artery-pulsatility index (MCA-PI), middle cerebral artery-resistance index (MCA-PR), umbilical artery-pulsatility index (UA-PI), umbilical artery-resistance index (UA-RI), middle cerebral artery to umbilical artery-resistance index ratio (MCA/UA-RI) and middle cerebral artery to umbilical artery- pulsatility index ratio (MCA/UA-PI) were measured. Neonates with less than 7 had low vital activities (appearance, pulse, grimace, activity, and respiration). Mean MCA-PI of anemic pregnant women with severe anemia was 1.4ms which was significantly lower than pregnant women with mild and moderate anemia, also mean MCA/UA-PI of anemic pregnant women with severe anemia was significantly lower than mild and moderate anemia with p-value <0.001. as well as the Mean neonatal HC of anemic pregnant women with severe anemia 30 cm which was significantly lower than HC of pregnant women with mild and moderate anemia (p=0.04), also mean neonatal AC of pregnant women with mild, moderate and severe, Current study showed no statistical difference in Apgar scores between the studies group, The validity results of MCA/UA-PI ratio regarding neonatal HC of anemic pregnant women are Sensitivity (22.2%), specificity (41.7%). Severe maternal anemia is found significantly associated with abnormal Doppler study middle cerebral artery to umbilical artery pulsatility

index. so Doppler middle cerebral artery to umbilical artery pulsatility index has limited validity in the prediction of neonatal outcomes in anemic pregnant women.



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## 1. Introduction

Doppler ultrasound would be a useful addition to our catalog of tests of antenatal fetal well-being and timely intervention. On the basis of abnormal Doppler results, obstetrical decision-making [1] might improve and prevent intrauterine death because hypoxic cerebral damage may begin before labor [2] and intrapartum asphyxia is probably more damaging when superimposed on underlying hypoxia.

The hypothesis that Doppler is effective in reducing mortality and major morbidity in high-risk pregnancies could only be tested with a massive randomized trial [3].

Doppler's investigation of a middle cerebral artery in combination with umbilical artery seems to improve the prediction of adverse outcomes in near-term pregnancies [3].

The maternal anemia, which sometimes reaches very low levels (maternal hemoglobin level, 40-50 g/L) is frequently associated with pre-maturity, reduced neonatal weight and infant iron deficiency and maternal anemia is also suspected to markedly reduce the oxygen supply to the fetus, which may be responsible for fetal blood flow redistribution, despite there being no evidence of placental insufficiency.

Distribution of fetal blood flow (between the placental and cerebral regions) is determined with Middle cerebral artery RI/Umbilical artery RI (C/U resistance ratio), which is the ratio between the cerebral (CRI) and umbilical (URI) resistance index. This parameter is always  $> 1.1$  during normal pregnancy, but decreases in the case of hypoxia because of the URI increase (increase in placental resistance) and CRI decreases (cerebral vasodilatation [4]).

## 2. Patients and methods

Present study is a clinical prospective study carried out in Al-Elwiya Maternity Teaching Hospital in Baghdad through the period from 1<sup>st</sup> of January to 31<sup>st</sup> of Jun, 2019.

Oral informed consent was taken from each woman before enrollment.

All anemic pregnant women presented to Obstetrical wards in Al-Elwiya Maternity Teaching Hospital for emergency cesarean section were the study population. The final sample selected was 120 term pregnant women after eligibility to inclusion and exclusion criteria.

The current study selected 120 term pregnant women with anemia admitted to hospital for caesarian section. Data were collected in a questionnaire. The information was taken from pregnant women directly.

Ultrasound was performed for all selected cases: fetal head circumference and abdominal circumference which was done by same Radiologist to eliminate inter-observer error.

Ultrasound Doppler velocimetry measurements like middle cerebral artery- peak systolic velocity (MCA-PSV), middle cerebral artery-pulsatility index (MCA-PI), middle cerebral artery-resistance index (MCA-PR), umbilical artery-pulsatility index (UA-PI), umbilical artery- resistance index (UA-RI), middle cerebral artery to umbilical artery- resistance index ratio (MCA/UA-RI) and middle cerebral artery to umbilical artery- pulsatility index ratio (MCA/UA-PI) were measured.

All neonates were examined measured by Pediatrician that was available at time of delivery for all following:

APGAR score were classified according to WHO definition into <7 and >7. Neonates with less than 7 had low vital activities (appearance, pulse, grimace, activity, and respiration.

Head circumference rule below was considered as abnormal head circumference was classified into small by (<34.5 cm for males and <33.8 cm for females).

Neonatal weight less than 2.5 Kg was regarded low.so the respiratory distress syndrome, NICU admission and duration of NICU admission was checked by the researcher.

Statistical analysis: The data of pregnant women were analyzed by application of Microsoft excel program and Statistical Package for Social Sciences (SPSS) version 23. The level of significance (p value) was set as ≤ 0.05.

### 3. Results

**Table (1):** Distribution of gestational ultrasound HC and AC means according to maternal anemia classification

Ultrasound variable	Mild anemia	Moderate anemia	Severe anemia	P
	Mean±SD (cm)	Mean±SD (cm)	Mean±SD (cm)	
HC (cm)	32.3±1.3	32.1±1.7	31.4±0.8	0.3*NS
AC (cm)	31.3±2.1	31±1.9	30±0.5	0.2*NS

\* One way ANOVA analysis, NS=Not significant.

The value of ultrasound Doppler parameters is shown in table 2 in relation to degree of maternal anemia only two variables were statistically significant.

Mean MCA-PI of anemic pregnant women with severe anemia was 1.4ms which was significantly lower than pregnant women with mild and moderate anemia (3.2 and 2.6 ms respectively), p was 0.03.

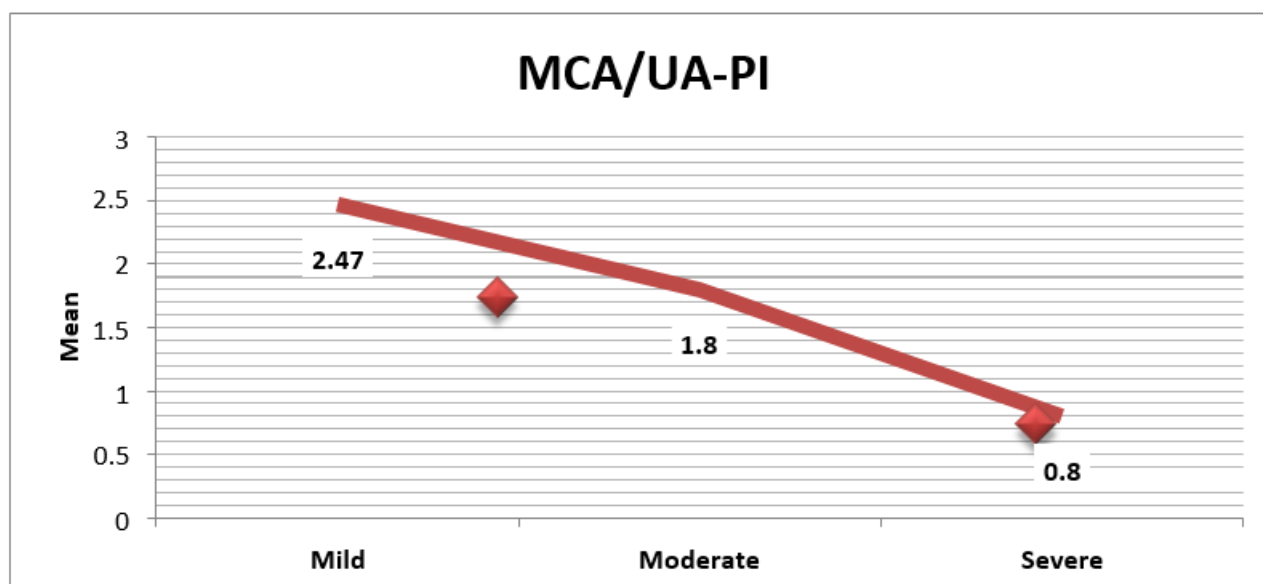
Mean MCA/UA-PI of anemic pregnant women with severe anemia was 0.8ms which was significantly lower than with mild and moderate anemia (2.47 and 1.8 ms respectively) with p-value <0.001, This is shown in figure-1.

**Table (2):** Distribution of ultrasound Doppler parameters means according to maternal anemia classification

Doppler ultrasound parameters	Mild anemia	Moderate anemia	Severe anemia	P
	Mean±SD	Mean±SD	Mean±SD	

CA-PSV (ms)	40.4±11.4	40.1±13.1	39.4±11.1	0.3*NS
CA-PI	3.2±1.5	2.6±1.8	1.4±0.15	<b>0.03</b> *S
CA-RI	0.9±0.1	0.8±0.1	0.8±0.1	0.1*NS
A-PI	0.8±0.1	0.7±0.2	0.8±0.02	0.4*NS
A-RI	0.5±0.07	0.5±0.1	0.5±0.006	0.3*NS
CA/UA-RI	1.7±0.4	1.7±0.5	1.5±0.2	0.4*NS
CA/UA-PI	2.47±0.6	1.8±0.8	0.8±0.5	<b>&lt;0.001</b> *S

\* One way ANOVA analysis, NS=Not significant, S=Significant



**Figure (1):** MCA/UA-PI ratio according to severity of anemia

Mean neonatal HC of anemic pregnant women with severe anemia 30 cm which was significantly lower than HC of pregnant women with mild and moderate anemia (31.8 and 31 cm respectively), p=0.04.

Mean neonatal AC of pregnant women with mild, moderate and severe anemia was 30.6, 30.1, and 29.5 cm respectively, which was not statistically significant.

Mean neonatal birth weight of anemic pregnant women with severe anemia was 2.6 Kg which was significantly lower than neonatal birth weight for pregnant women with mild and moderate anemia (3.3 and 3 Kg respectively), p<0.001.

There was no statistical difference in Apgar scores between the studies group, all those findings are shown in table 3, figure 2 and 3.

**Table (3):** Distribution of neonatal outcome measures according to maternal anemia classification

Variable	Mild anemia	Moderate anemia	Severe anemia	P
	Mean±SD	Mean±SD	Mean±SD	

Neonatal HC (cm)	31.8±0.7	31±1.4	30±0.8	<b>0.04</b> *S
Neonatal AC (cm)	30.6±1.1	30.1±1.4	29.5±0.8	0.07*NS
Neonatal weight (Kg)	3.3±0.3	3±0.18	2.6±0.13	<b>&lt;0.001</b> *S
pgar score at 1 minute	7.5±0.4	7.4±0.4	7.5±0.4	0.6*NS
pgar score at 5 minutes	9.5±0.4	9.5±0.4	9.7±0.2	0.2*NS

\* One way ANOVA analysis, NS=Not significant, S=Significant

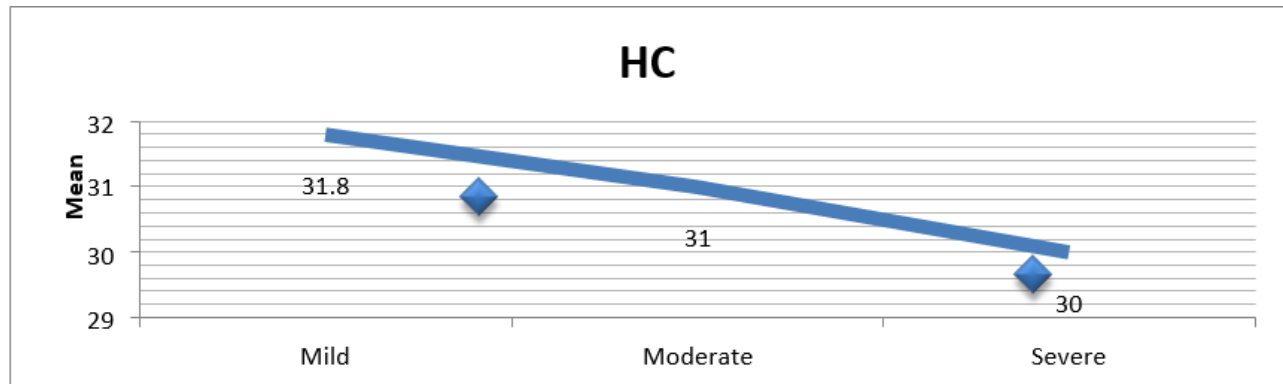


Figure (2): Neonatal HC according to severity of anemia

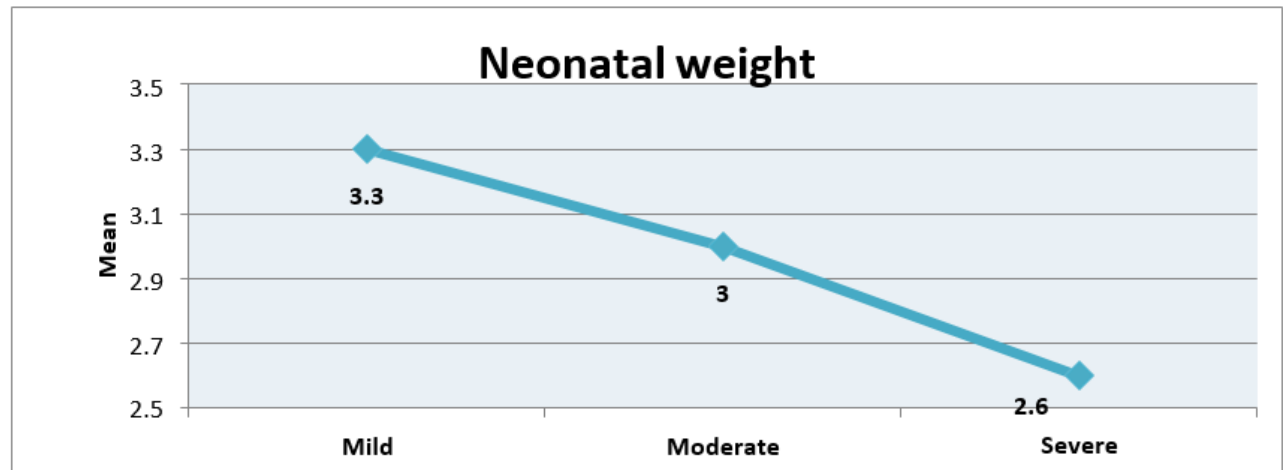


Figure (3): Neonatal weight according to the severity of anemia

The validity results of MCA/UA-PI ratio regarding neonatal HC of anemic pregnant women are shown in table (4). Sensitivity (22.2%), specificity (41.7%), +ve predictive value (77.4%), -ve predictive value (5.6%) and accuracy (24.1%).

Table (4): Validity test results of MCA/UA-PI ratio in comparison to neonatal HC.

Validity test			Neonatal HC		
			Normal	Small	Total
			No. (%)	No. (%)	No. (%)
MCA/UA ratio	Abnormal	(%)	24 (77.4)	7 (22.6)	31 (100.0)
	Normal	(%)	84 (94.4)	5 (5.6)	89 (100.0)

	<b>Total</b>	(%)	108 (90.0)	12 (10.0)	120 (100.0)
<b>Sensitivity</b>			22.2%		
<b>Specificity</b>			41.7%		
<b>+ve predictive value</b>			77.4%		
<b>-ve predictive value</b>			5.6%		
<b>Accuracy</b>			24.1%		

\*P=0.07 (not-significant)

Table -5 shows that the validity results of MCA/UA-PI ratio regarding neonatal birth weight of anemic pregnant women were sensitivity (35.5%), specificity (78.3%), +ve predictive value (35.5%), -ve predictive value (80.9%) and accuracy (69.1%).

**Table (5):** Validity test results of MCA/UA-PI ratio in comparison to neonatal birth weight.

Validity test			Neonatal HC		
			<3 Kg	≥3 Kg	Total
			No. (%)	No. (%)	No. (%)
<b>MCA/UA ratio</b>	<b>Abnormal</b>	(%)	11 (35.5)	20 (64.5)	31 (100.0)
	<b>Normal</b>	(%)	17 (19.1)	72 (80.9)	89 (100.0)
	<b>Total</b>	(%)	28 (90.0)	92 (10.0)	120 (100.0)
<b>Sensitivity</b>			39.3%		
<b>Specificity</b>			78.3%		
<b>+ve predictive value</b>			35.5%		
<b>-ve predictive value</b>			80.9%		
<b>Accuracy</b>			69.1%		

\*P=0.06 (Not significant).

#### 4. Discussion

The present study showed that mean middle cerebral artery to umbilical artery pulsatility index (MCA/UA PI) of pregnant women with severe anemia was significantly higher than pregnant women with mild and moderate anemia. A recent study by [5] documented that vasodilation of fetal middle cerebral artery was observed among pregnant women with severe anemia lead to changes in Doppler middle cerebral artery and umbilical artery indices. Anemia in pregnancy is found to be related to oxygen supply reduction to fetuses that lead to rearrangement of fetal blood supply although good placental blood supply [6]. Rearrangement of fetal blood supply which is due to low oxygen causes fetal hypoxemia and centralization of fetal blood flow for purpose of maintaining of cerebral oxygenation which is called brainsparing reflex that occurs is sequence of adaptation of fetuses to severe reduction of oxygen [7].

This finding of MCA/UA PI is similar to results of [7] prospective case-control clinical trial in Egypt on 200 pregnant women at late trimester which found that the middle cerebral artery to umbilical artery pulsatility index showed a significant increase among pregnant women with severe anemia than other anemia groups. In the current study, mean middle cerebral artery pulsatility index of anemic pregnant

women with severe anemia was significantly lower than pregnant women with mild and moderate anemia ( $p=0.03$ ). This finding is consistent with results of [5] study in Turkey which found that Doppler umbilical artery measurements of pregnant women with iron deficiency anemia were not significantly different from controls. Our study also showed no significant difference in mean of middle cerebral artery peak velocity regarding anemia severity. This finding is inconsistent with results of [9] study in Egypt which reported higher middle cerebral artery peak velocity among pregnant women with severe anemia. Mean middle cerebral artery to umbilical artery resistance index of pregnant women was not significantly related their anemia classification. This finding is inconsistent with results of [10] study in Serbia which stated that Doppler middle cerebral artery to umbilical artery resistance index is a common predictor for anemia severity for both women and fetuses. Recent studies were agreement with our finding about MCA/UA PI. Present study showed severe maternal anemia is found significantly associated with abnormal Doppler study middle cerebral artery to umbilical artery pulsatility index with acceptable validity results of sensitivity (81.8%), specificity (79.8%), and accuracy (80%). These findings are in Severe maternal anemia is found significantly associated with abnormal Doppler study middle cerebral artery to umbilical artery pulsatility index agreement with results of [7] study in Egypt and [11] study in USA which revealed that middle cerebral artery to umbilical artery pulsatility index is the better Doppler velocemetry index in prediction of severe maternal anemia.

Our study shows that shows low validity results of MCA/UA-PI ratio regarding neonatal HC of anemic pregnant women were sensitivity (22.2%), specificity (41.7%) and accuracy (24.1%). These findings are similar to results of [12] systematic review study in UK which revealed that middle cerebral artery to umbilical artery pulsatility index had a limited accuracy in the prediction of neonatal outcomes. Another study conducted in UK by [13] showed that umbilical and fetal middle cerebral artery pulastility index have poor performance in prediction of perinatal outcomes. However, another American study at the same year that middle cerebral artery to umbilical artery pulsatility index is a significant predictor of small for gestational age [14]. In the present study, the validity results of MCA/UA-PI ratio regarding the neonatal birth weight of anemic pregnant women were sensitivity (35.5%), specificity (78.3%) and accuracy (69.1%) with no significant relationship. These findings are inconsistent with results of Patange and Goel study in India which reported that the middle cerebral artery to umbilical artery pulsatility index is helpful in prediction of low birth weight at the third trimester of pregnancy [15].

## 5. Conclusion

- Severe maternal anemia is found significantly associated with abnormal Doppler study middle cerebral artery to umbilical artery pulsatility index.
- The Doppler middle cerebral artery to umbilical artery pulsatility index has limited validity in the prediction of neonatal outcomes in anemic pregnant women.
- The neonatal head circumference and birth weight are more likely to be reduced with severe maternal anemia.

Ethical approval:

The ethical approval for this study was acquired from the Gynecology & Obstetrics Scientific Council of the Arab Board for Health Specialties.

## 6. References

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