RESEARCH PAPER

The Association Between Clinical, Laboratory and Ultrasonographic Findings with Development of Maternal and Neonatal Complications in Women with Severe Preeclampsia

Mohamed Shalaby [1], Basma El-Bokl [1], Wael El-Sherbiny [1], Nour A El-Goly [2], Ahmed M Maged [1*], Noha Salah [1]

1 Faculty of Medicine, Cairo University, Cairo, Egypt
2 Department of Obstetrics and Gynecology, Kasr Al-Ainy Hospital, Cairo University, Cairo, Egypt

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ABSTRACT

Objective: to assess the value of various risk factor to predict maternal and neonatal outcomes in women with severe PE.

Methods: This prospective cohort study was conducted on 284 pregnant women diagnosed with severe preeclampsia. All participants were evaluated through complete history, examination, laboratory investigations including complete blood count, complete urine analysis, liver enzymes, serum creatinine and coagulation profile and obstetric ultrasound with Umbilical artery doppler. The outcome parameters included the development of maternal complications as eclampsia, acute pulmonary edema, HELLP syndrome, and renal failure, neonatal intensive care unit admission and relation between uterine artery doppler and development of both maternal and neonatal complications.

Results: The GA at termination was significantly lower (34.59 ± 1.81 vs. 35.55 ± 1.49, P <0.001), both SBP (187.86 ± 13.85 vs. 172.00 ± 12.97, P <0.001) and DBP (119.11 ± 9.54 vs. 108.60 ± 6.64 , P<0.001) were significantly higher, the adverse neonatal outcomes including SGA (80.4 vs 22.4%, P<0.001), RDS (37.5 vs. 19.7%, P = 0.005), NICU admission (57.1 vs. 33.8%, P=0.001), perinatal death (8.9 vs. 1.8%, P=0.006) were significantly higher while Apgar scores at both 1 (4.27 ± 0.82 vs. 4.60 ± 0.83, P =0.007) and 5 minutes (7.43 ± 1.02 vs. 7.72 ± 0.5, P= 0.019) were significantly lower in women who experienced maternal complication compared to those without any maternal complications .

There was a significant difference in UA PI in women maternal complications (1.27 ± 0.26 vs. 0.94 ± 0.21, P<0.001), needing ICU admission (1.26 ± 0.28 vs. 0.97 ± 0.23, P<0.001), needing neonatal ICU admission (1.12 ± 0.25 vs. 0.94 ± 0.23, P<0.001) and those with perinatal deaths (1.28 ± 0.28 vs. 1.09 ± 0.26, P=0.002) compared to other women.

Conclusion: UA Doppler had significantly higher resistance in women with complicated severe PE, women who needed ICU admission, women whose neonates needed ICU admission suffering from TTN or RDS and those with neonatal perinatal deaths.

Trial Registration number NCT07125599 Date of registration 9/8/2025.

Keywords: Severe preeclampsia; Maternal outcome; neonatal outcome; predictors; Umbilical artery Doppler

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INTRODUCTION

Preeclampsia (PE) is defined as the development of new onset hypertension after 20 weeks of gestational age in a previously normotensive women and associated with end organ dysfunction. PE complicates 2 – 8% of all pregnancies and accounts for 9% of maternal mortalities in Africa and Asia and 26% in Latin America and the Caribbean (1).

The exact etiology of PE is not fully understood. Risk factors include advanced maternal age, nulliparity, obesity, prior history of PE in previous pregnancy, chronic hypertension, pregestational diabetes, renal diseases and antiphospholipid syndrome. Genetic predisposition is also recently suggested and a single-nucleotide polymorphism near the FLT1 locus at chromosome 13 that affects the placental and vascular endothelial growth factors leading to endothelial dysfunction (2).

The pathogenesis of PE is related to inadequate trophoblastic invasion and spiral arteries remodeling with the resultant placental hypoperfusion and release of angiogenic factors from the ischemic placenta leading to generalized endothelial dysfunction (3).

Eight percent of all pregnancy related complications are related to PE with over 50,000 maternal death and 500000 fetal death rates (4).

Maternal complications of PE include eclamptic fits, HELLP syndrome, placental abruption, pulmonary edema, vital organ damage and even failure including liver, kidney, lungs and brain and even maternal death. Fetal complications include fetal growth restriction, prematurity (spontaneous or induced) with its consequences, placental abruption with intrauterine fetal death and neonatal death (5).

**Author for Correspondence: Ahmed M Maged*

Before delivery clinical, laboratory and ultrasonographic assessments are required to evaluate both maternal and fetal conditions. Clinical evaluation included blood pressure measurements, symptoms evaluation, detailed examination, laboratory measurement of serum creatinine, proteinuria, liver transaminases and hemogram including platelet count (6).

Ultrasound assessment of fetal growth, well-being and amniotic fluid is crucial in women with PE. Doppler ultrasound is a non-invasive tool for assessment of placental insufficiency and fetal well-being that is commonly used in these women. Doppler evaluation included uterine, middle cerebral, and umbilical arteries flow measurements (7).

The aim of this study is to assess the value of various risk factor to predict maternal and neonatal outcomes in women with severe PE.

MATERIAL AND METHODS

This prospective cohort study was conducted in accordance with the Declaration of Helsinki on 284 pregnant women diagnosed with severe preeclampsia attended kasr Alainy maternity hospital between May 2020 and April 2025. The study was approved by kasr Alainy ethical committee on 4th of April 2020 number MD-184-2019 and registered on clinical trial registry with NCT07125599 number. All participants have signed an informed written consent after explanation of the aims, procedures and benefits of the study.

Women included in this study aged between 18 and 40 years and pregnant with a single living fetus more than 28 weeks of gestational age. They were diagnosed with severe preeclampsia based on ACOG guidelines (1). The criteria for diagnosis are based on the presence of at least one of the following systolic blood pressure 160 mmHg or more, diastolic blood pressure 110 mmHg or more, impaired liver or kidney functions, new onset visual or cerebral disturbances, pulmonary edema or low platelet count < 100,000/μL.

Women with other maternal medical disorders as liver, kidney, cardiac, endocrinal, metabolic, inflammatory, or immune diseases were excluded from the study. Women carrying anomalous fetus, had rupture of membrane and those received any respiratory depressants within 2 hours of delivery were also excluded.

All participants were evaluated through complete history and examination. Laboratory investigations included complete blood count, complete urine analysis, liver enzymes, serum creatinine and coagulation profile. Obstetric ultrasound examination was done for all participants to assess fetal viability, fetal size, gestational age, placental maturity and amniotic fluid volume. Umbilical artery doppler was measured using GE voluson E10 (GE Healthcare, Milwaukee, WI, USA) using 2.5 – 5 MHz abdominal probe by one author (BE). Evaluation was done with the women in the semi recumbent position with angle of insonation < 45 degrees and pass filter setted at 100 Hz in absence of fetal body or respiratory movements (8).

All women were managed using kasr Alainy protocol for PE. Intravenous (IV) hydralazine was used to control blood pressure with 5 -10 mg initial dose over 2 minutes then 10 mg was given every 10 – 20 minutes to maintain blood pressure below 160/ 110. Magnesium sulfate was initiated with IV 4-6 gm in 100 ml normal saline over 20 minutes then maintained by 1 – 2 gm per hour as a maintenance dose in all women and this was maintained for 24 hours after pregnancy termination (9).

After stabilization of the patient condition the timing and route of termination of pregnancy was determined according to maternal and fetal assessment. A team of expert obstetrician, anesthesiologist and neonatologist attended all deliveries.

The outcome parameters included the development of maternal complications as eclampsia, acute pulmonary edema, HELLP syndrome, and renal failure, neonatal intensive care unit admission and relation between uterine artery doppler and development of both maternal and neonatal complications.

STATISTICAL METHODS:

Statistical analyses were performed using IBM SPSS Statistics version 27. Continuous variables were expressed as mean ± standard deviation (95% confidence interval), while categorical variables were presented as numbers (%). Normality of data distribution was assessed using the Shapiro-Wilk test. Comparisons between groups for continuous variables were performed using independent samples t-tests (for normally distributed data) or Mann-Whitney U tests (for non-normally distributed data). Categorical variables were compared using Chi-square tests or Fisher's exact tests, as appropriate. Receiver operating characteristic (ROC) curve analysis was conducted to evaluate the predictive performance of uterine artery pulsatility index (UA PI) for adverse clinical outcomes, with area under the curve (AUC) values calculated to determine discriminatory ability. Optimal cutoff values were identified using the Youden index to maximize both sensitivity and specificity. For each predictive model, we calculated sensitivity (true positive rate), specificity (true negative rate), positive predictive value (PPV), negative predictive value (NPV), and overall accuracy to comprehensively evaluate clinical utility. Statistical significance was set at $p < 0.05$.

RESULTS

During the study period 391 women diagnosed with severe PE, 284 of them signed the informed consent for participation in this study.

The demographic characteristics, maternal and fetal outcomes are described in table 1.

There were no significant differences between women with complications and those without any maternal complications regarding age, BMI, parity, or mode of delivery (table 1).

The GA at termination was significantly lower, both SBP and DBP were significantly higher, the adverse neonatal outcomes including SGA, RDS, NICU admission, perinatal death were significantly higher while Apgar scores at both 1 and 5 minutes were significantly lower in women who experienced maternal complication compared to those without any maternal complications (table 1).

There were no significant differences between women with neonatal ICU admission and those without other women regarding age, BMI, GA at termination, SBP, parity, or mode of delivery (table 1).

The DBP and maternal complications named placental abruption, HELLP syndrome, postpartum hemorrhage and ICU admission were significantly higher in women with neonatal ICU admission when compared to other women (table 1).

There was a significant difference in UA PI in women maternal complications, needing ICU admission, needing neonatal ICU admission and those with perinatal deaths compared to other women (table 2).

The diagnostic performance of UA PI in detection of maternal and neonatal complications is described in table 3.

The association between gestational age at termination, systolic blood pressure, diastolic blood pressure, hemoglobin, platelet count, ALT, AST, serum creatinine and individual maternal complications are shown in table 4.

Table 1 characteristics of the study population

		Maternal complications			NICU admission			
		Yes (n=56)	No (n=228)	P value	Yes (n=109)	No (n=175)	P value	
Age (years)		27.96 ± 6.05 (26.34–29.58)	29.22 ± 5.94 (28.45–29.99)	0.159	29.32 ± 6.06 (28.17–30.47)	28.75 ± 5.91 (27.87–29.63)	0.437	28.97 ± 5.97 (28.27–29.67)
BMI (kg/m^2)		29.76 ± 4.60 (28.53–30.99)	30.07 ± 3.69 (29.59–30.55)	0.591	29.96 ± 4.40 (29.13–30.79)	30.03 ± 3.53 (29.51–30.56)	0.880	30.00 ± 3.88 (29.55–30.46)
GA at termination (weeks)		34.59 ± 1.81 (34.11–35.07)	35.55 ± 1.49 (35.35–35.75)	**<0.001**	35.17 ± 1.62 (34.86–35.48)	35.48 ± 1.59 (35.24–35.72)	0.118	35.36 ± 1.61 (35.17–35.55)
SBP (mmHg)		187.86 ± 13.85 (184.15–191.57)	172.00 ± 12.97 (170.31–173.69)	**<0.001**	176.79 ± 14.67 (174.02–179.56)	174.09 ± 14.44 (171.94–176.24)	0.132	175.18 ± 14.54 (173.48–176.88)
DBP (mmHg)		119.11 ± 9.54 (116.56–121.66)	108.60 ± 6.64 (107.73–109.47)	**<0.001**	113.49 ± 8.78 (111.84–115.14)	108.91 ± 7.67 (107.77–110.05)	**<0.001**	110.70 ± 8.41 (109.71–111.69)
Parity	Nulli	30 (53.6%)	118 (51.8%)	0.087	56 (51.4%)	92 (52.6%)	0.370	148 (52.1%)
	Multi	25 (46.5%)	110 (48.2%)		53 (48.6%)	83 (47.4%)		136 (47.9%)
Mode of delivery	VD	18 (32.1%)	87 (38.2%)	0.403	33 (30.3%)	72 (41.1%)	0.056	105 (37.0%)
	CD	38 (67.9%)	141 (61.8%)		76 (69.7%)	103 (58.9%)		179 (63.0%)
Maternal investigations	Hb (gm/dL)	9.85 ± 1.56 (9.43–10.27)	11.46 ± 1.44 (11.27–11.65)	**<0.001**	10.83 ± 1.61 (10.52–11.14)	11.33 ± 1.56 (11.10–11.56)	**0.009**	11.14 ± 1.59 (10.95–11.33)
	Platelet 10^3/L	154.21 ± 104.17 (126.34–182.08)	261.87 ± 57.19 (253.44–270.30)	**<0.001**	221.39 ± 93.33 (203.81–238.97)	252.63 ± 70.05 (242.25–263.01)	**0.001**	240.74 ± 81.77 (231.15–250.33)
	AST (IU/L)	103.61 ± 100.70 (76.67–130.55)	27.94 ± 9.52 (26.70–29.18)	**<0.001**	57.00 ± 77.46 (42.43–71.57)	34.06 ± 29.60 (29.67–38.45)	**0.001**	42.80 ± 54.13 (36.49–49.11)
	ALT (IU/L)	102.41 ± 87.18 (79.09–125.73)	28.75 ± 11.09 (27.31–30.19)	**<0.001**	55.98 ± 64.70 (43.87–68.09)	35.35 ± 34.68 (30.21–40.49)	**<0.001**	43.40 ± 49.41 (36.59–50.21)
	Creatinine (mg/dL)	1.28 ± 1.26 (0.94–1.62)	0.89 ± 0.19 (0.87–0.92)	**0.002**	0.99 ± 0.72 (0.85–1.12)	0.95 ± 0.52 (0.88–1.03)	0.665	0.97 ± 0.60 (0.90–1.04)
	UAPI	1.27 ± 0.26 (1.20–1.34)	0.94 ± 0.21 (0.91–0.97)	**<0.001**	1.12 ± 0.25 (1.07–1.16)	0.94 ± 0.23 (0.91–0.97)	**<0.001**	1.01 ± 0.25 (0.98–1.04)
Maternal complications	Any	56 (19.7%)	------	------	32 (29.4%)	24 (13.7%)	**0.001**	56 (19.7%)
	Eclampsia	28 (9.9%)			13 (11.9%)	15 (8.6%)	0.356	28 (9.9%)
	Placental abruption	18 (6.3%)			13 (11.9%)	5 (2.9%)	**0.002**	18 (6.3%)
	ARF	4 (1.4%)			2 (1.8%)	2 (1.1%)	0.630	4 (1.4%)
	APE	7 (2.5%)			4 (3.7%)	3 (1.7%)	0.301	7 (2.5%)
	HELLP	34 (12.0%)			24 (22.0%)	10 (5.7%)	**<0.001**	34 (12.0%)
	DIC	4 (1.4%)			2 (1.8%)	2 (1.1%)	0.621	4 (1.4%)
	PPH	34 (12.0%)			24 (22.0%)	10 (5.7%)	**<0.001**	34 (12.0%)
	ICU admission	37 (13.0%)			24 (22.0%)	13 (7.4%)	**<0.001**	37 (13.0%)
Neonatal outcomes	Apgar 1 min	4.27 ± 0.82 (4.05–4.49)	4.60 ± 0.83 (4.49–4.71)	**0.007**	3.62 ± 0.56 (3.51–3.73)	5.10 ± 0.31 (5.06–5.14)	**<0.001**	4.54 ± 0.87 (4.44–4.65)
	Apgar 5 min	7.43 ± 1.02 (7.16–7.70)	7.72 ± 0.5 (7.62–7.82)	**0.019**	6.77 ± 0.54 (6.67–6.87)	8.22 ± 0.42 (8.16–8.28)	**0.001**	7.67 ± 0.83 (7.57–7.77)
	SGA	45 (80.4%)	51 (22.4%)	**<0.001**	66 (60.6%)	30 (17.1%)	<0.001	96 (33.8%)
	TTN	11 (19.6%)	32 (14.0%)	0.294	66 (60.6%)	0	-------	43 (15.1%)
	RDS	21 (37.5%)	45 (19.7%)	**0.005**	43 (39.4%)	0	-------	66 (23.2%)
	NICU admission	32 (57.1%)	77 (33.8%)	**0.001**		0	-------	109 (38.4%)
	Perinatal death	5 (8.9%)	4 (1.8%)	**0.006**	9 (8.3%)	0	-------	9 (3.2%)

ALT Alanine transaminase, AST Aspartate transaminase, APE Acute pulmonary edema, ARF Acute renal failure, BMI Body mass index, CD Cesarean delivery, DBP Diastolic blood pressure ,DIC Disseminated intravascular coagulopathy, GA Gestational age, ICU intensive care unit, PPH Postpartum hemorrhage, RDS respiratory distress syndrome, SBP Systolic blood pressure, SGA Small for age, TTN Transient tachypnea of newborn, UA PI Umbilical artery pulsatility index, VD Vaginal delivery

Table 2: UA PI Values by Clinical Outcome Group

Outcome Group	Subgroup	N	UA PI		P-value*
			Mean ± SD	95% CI for Mean	
Maternal Comp.	**No Comp.**	228	0.94 ± 0.21	(0.91 - 0.97)	**< 0.001**
	With Comp.	56	1.27 ± 0.26	(1.20 - 1.34)	
ICU Admission	**No ICU**	247	0.97 ± 0.23	(0.94 - 0.99)	**< 0.001**
	ICU	37	1.26 ± 0.28	(1.16 - 1.36)	
NICU Admission	**No NICU**	175	0.94 ± 0.23	(0.91 - 0.97)	**< 0.001**
	NICU	109	1.12 ± 0.25	(1.07 - 1.16)	
TTN	**No**	241	0.98±0.29	(0.95 - 0.99)	**0.010**
	Yes	43	1.11±0.26	(1.05 -1.20)	
RSD	**No**	218	0.97±0.25	(0.95 - 0.99)	**< 0.001**
	Yes	66	1.13±0.26	(1.05 - 1.37)	
Perinatal death	**No**	275	1.09±0.26	(1.02 - 1.17)	**0.002**
	Yes	9	1.28±0.28	(1.15 - 1.33)	

Values are presented as Mean ± SD (95% Confidence Interval). * p-value is from the independent samples t-tests (for normally distributed data) or Mann-Whitney U tests (for non-normally distributed data). Significant p-values ($p < 0.05$) are in bold.

Table:**3** Statistical calculations for the diagnostic performance of UA PI

Study Outcomes	AUC	SE	95% Confidence Interval for AUC	Cutoff Value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	P-value
Overall Maternal Complication	0.832	0.031	0.77 – 0.89	1.18	62.5	87.7	55.6	90.5	82.7	**<0.001**
Eclampsia	0.812	0.044	0.73 – 0.90	0.89	92.9	65.2	22.6	98.8	68.0	**<0.001**
HELLP	0.804	0.041	0.72 – 0.89	0.88	91.2	64.8	26.1	98.2	68.0	**<0.001**
Placental abruption	0.858	0.050	0.76 – 0.96	0.87	94.4	33.8	8.8	98.9	37.7	**<0.001**
ARF	0.772	0.105	0.57 – 0.98	0.95	75.0	53.9	0.65	99.6	54.2	**<0.001**
APE	0.705	0.092	0.52 – 0.89	0.88	85.7	67.5	2.2	99.6	67.6	**0.026**
DIC	0.874	0.075	0.73 – 1.02	0.87	100.0	32.5	2.1	100.0	33.5	**<0.001**
ICU Admission	0.780	0.041	0.69 – 0.86	1.25	56.8	83.0	55.6	90.5	79.6	**<0.001**
NICU Admission	0.696	0.032	0.63 – 0.76	1.02	58.7	71.4	56.1	73.5	66.5	**<0.001**
TTN	0.614	0.048	0.52 – 0.71	1.02	55.8	62.7	21.1	88.8	61.6	**0.017**
RDS	0.678	0.036	0.61–0.75	1.015	60.6	66.1	22.3	92.6	64.8	**<0.001**
Prenatal death	0.761	0.081	0.60 – 0.92	0.97	77.8	48.5	7.9	98.8	50.7	**0.001**

AUC, area under the curve; NPV, negative predictive value; PPV, positive predictive value. diagnostic performance (Youden's index) UA PI: Uterine Artery Pulsatility Index; Note, the PPV reported for perinatal death (7.9%) is likely to be very low because the prevalence of perinatal death is extremely low (just 9 out of 284 cases, or 3.2%). The PPV is low because the condition (eclampsia) is relatively rare in the population. The low PPV is statistically correct due to the small number of HELLP cases; most positives at this cutoff will be false positives

**Author for Correspondence: Ahmed M Maged*

Table 4 relation of predictors with individual complications

		Eclampsia			Abruptioplacenta			ARF			APE		
		No	Mean ± SD	P value	No	Mean ± SD	P value	No	Mean ± SD	P value	No	Mean ± SD	P value
GA at termination (weeks)	Yes	27	34.33 ± 2.02	<0.001	18	34.5± 1.58	0.018	4	34.75 ±2.22	0.443	7	33.29 ± 2.50	<0.001
	No	257	35.47 ± 1.52		266	35.42 ± 1.59		280	35.37 ± 1.6		277	35.42 ± 1.55	
SBP (mmHg)	Yes	27	196.67 ± 6.79	<0.001	18	180 ± 16.09	0.142	4	177.5 ± 20.62	0.743	7	200 ± 10	<0.001
	No	257	172.86 ± 13.52		266	174.79 ± 14.43		280	175.09 ± 14.51		277	174.49 ± 14.11	
DBP (mmHg)	Yes	27	116.3 ± 12.14	<0.001	18	119.72 ± 1.18	<0.001	4	121.25 ±6.29	0.011	7	134.29 ± 5.35	<0.001
	No	257	110.08 ± 7.71		266	110.06 ± 8.33		280	110.52 ± 8.34		277	110.07 ± 7.57	
Hb (gm/dL)	Yes	27	10.33 ± 1.65	0.006	18	9.43 ± 1.51	<0.001	4	8.92 ± 1.4	0.005	7	9.21 ± 0.95	0.001
	No	257	11.22 ± 1.57		266	11.25 ± 1.53		280	11.17 ± 1.58		277	11.19 ± 1.58	
Platelet count (10^3/L)	Yes	27	228.67 ± 101.62	0.421	18	79.83 ± 18.01	<0.001	4	93 ± 7.62	<0.001	7	122.14 ± 89.66	<0.001
	No	257	241.9 ± 78.75		266	251.52 ± 71.58		280	242.75 ± 79.69		277	243.64 ± 78.74	
ALT (IU/L)	Yes	27	55.04 ±64.11	0.194	18	143.72 ± 74.97	<0.001	4	84 ± 53.73	0.097	7	135.71 ± 116	<0.001
	No	257	42.04 ± 47.56		266	36.47 ± 38.875		280	42.69 ± 49.17		277	40.94 ± 44.55	
AST (IU/:L)	Yes	27	69.85 ± 108.97	0.006	18	134.78 ± 77.43	<0.001	4	69.25 ± 47.8	0.329	7	167.57 ± 192.26	<0.001
	No	257	40.03 ± 44.47		266	36.64 ± 46.44		280	42.49 ± 54.41		277	39.71 ± 42.66	
Creatinine (mg/dL)	Yes	27	0.93 ± 0.28	0.764	18	1.62 ± 1.79	<0.001	4	5.625 ± 0.964	<0.001	7	1.043 ± 0.181	0.735
	No	257	0.97 ± 0.63		266	0.92 ± 0.39		280	0.9 ± 0.208		277	0.965 ± 0.61	
UA	Yes	27	1.305 ± 0.25	<0.001	18	1.37 ± 0.26	<0.001	4	1.273 ± 0.293	0.034	7	1.211 ± 0.303	0.030
	No	257	0.974 ± 0.233		266	0.981 ± 0.233		280	1.002 ± 0.252		277	1.0 ± 0.251	

Table 4 relation of predictors with individual complications (continued)

		HELLP			DIC			PPH			ICU admission		
		No	Mean ± SD	P value	No	Mean ± SD	P value	No	Mean ± SD	P value	No	Mean ± SD	P value
GA at termination	Yes	34	34.62 ± 1.91	0.004	4	35.25 ± 0.96	0.888	21	34.57 ± 1.99	0.019	37	34.57 ± 1.89	0.001
	No	250	35.46 ± 1.53		280	35.36 ± 1.61		263	35.43 ± 1.56		247	35.48 ± 1.52	
SBP	Yes	34	182.94 ± 15.28	0.001	4	172.5 ± 15	0.717	21	182.38 ± 13	0.017	37	184.59 ± 15.74	<0.001
	No	250	174.06 ± 14.16		280	175.16 ± 14.58		263	174.54 ± 14.55		247	173.7 ± 13.86	
DBP	Yes	34	122.35 ± 6.42	<0.001	4	120 ± 0.01	0.025	21	122.38 ± 6.25	<0.001	37	123.24 ± 6.99	<0.001
	No	250	109.08 ± 7.32		280	110.54 ± 8.39		263	109.73 ± 7.83		247	108.79 ± 6.83	
Hb	Yes	34	9.42 ± 1.39	<0.001	4	8.6 ± 0.94	0.001	21	9.16 ± 1.47	<0.001	37	9.47 ± 1.36	<0.001
	No	250	11.37 ± 1.47		280	11.18 ± 1.57		263	11.3 ± 1.5		247	11.39 ± 1.47	
Platelet count	Yes	34	77.18 ± 20.08	<0.001	4	81 ± 19.65	<0.001	21	69.48 ± 20.86	<0.001	37	89.11 ± 46.55	<0.001

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	No	250	262.87 ± 57.21		280	242.92 ± 79.33		263	254.31 ± 67.31		247	263.34 ± 57.22	
ALT	Yes	34	150.97 ± 80.25	<0.001	4	132.5 ± 65.14	<0.001	21	180.9 ± 85.86	<0.001	37	142.19 ± 82.5	<0.001
	No	250	28.62 ± 19.87		280	42 ± 48.08		263	32.28 ± 20.76		247	28.45 ± 10.79	
AST	Yes	34	152.76 ± 102.6	<0.001	4	97 ± 43.98	0.045	21	177.05 ± 113.27	<0.001	37	143.14 ± 103.59	<0.001
	No	250	27.92 ± 9.36		280	42.09 ± 54.15		263	32.15 ± 25.53		247	27.84 ± 9.38	
Creatinine	Yes	34	1.476 ± 1.583	<0.001	4	1.75 ± 1.63	0.009	21	1.138 ±0.752	0.176	37	1.446 ± 1.52	<0.001
	No	250	0.897 ± 0.203		280	0.955 ± 0.576		263	0.953 ± 0.589		247	0.895 ± 0.201	
UA	Yes	34	1.281 ± 0.271	<0.001	4	1.4 ± 0.267	0.002	21	1.305 ± 0.248	<0.001	37	1.256 ± 0.276	<0.001
	No	250	0.968 ± 0.227		280	1 ± 0.25		263	0.982 ± 0.239		247	0.969 ± 0.228	

DISCUSSION

This study confirmed that women with complicated severe PE had a significantly smaller GA at termination, higher blood pressure, lower Apgar scores, higher rates of SGA, RDS, and neonatal ICU admission.

We found that UA Doppler had significantly higher resistance in women with complicated severe PE, women who needed ICU admission, women whose neonates needed ICU admission suffering from TTN or RDS and those with neonatal perinatal deaths.

In this trial, the UA resistance proved to be a good predictor for detection of development of maternal complications and maternal ICU admission and moderate accuracy for detection of eclampsia, HELLP syndrome, acute pulmonary edema, and neonatal ICU admission.

This association is expected as the vascular affection is more extensive in those with high UA resistance. This finding is reflected clinically through documentation of higher maternal complications as a result of systemic endothelial dysfunctions and higher fetal / neonatal complications as a result of placental vascular insufficiency (10).

Core and colleagues (10) evaluated the association between UA doppler and pregnancy outcomes in their retrospective cohort study conducted on 107 women diagnosed with early severe PE. They found that the high resistance reported within the UA was associated with earlier delivery (OR=3.91; 95% CI 1.24-12.33), higher rates of CD (OR=0.12; 95% CI 0.03-0.54), higher risk of adverse neonatal outcomes (OR=6.46; 95% CI 1.42-29.42) and RDS (OR=4.75; 95% CI 1.32-17.16). They concluded that the UA doppler could be used in women with severe PE to predict the adverse pregnancy outcomes.

Zhang and colleagues (11) in a retrospective study evaluated the value of UA doppler and serum adiponectin in prediction of maternal- fetal/neonatal outcomes in 118 women with severe PE and compared the results to 90 controls. They found that the use of UA doppler with serum adiponectin had specificity and sensitivity of 60.27 % and 60%, respectively (AUC 0.6545) for prediction of adverse pregnancy outcomes.

El-Demiry and colleagues in 2020 (8) evaluated the value of different doppler parameters including UA in prediction of adverse fetal/neonatal outcomes in 60 women diagnosed with severe PE. They reported higher UAPI in women with adverse compared to those without adverse perinatal outcome (1.28 ± 0.23 vs. 0.96 ± 0.21, respectively, P <0.001). They found that UAPI has a high specificity, and RI has a high sensitivity in prediction of these adverse effects.

Also Maged and coworkers in 2020 (12) reported a higher rate of adverse perinatal outcomes named lower Apgar scores, smaller birth weight, NICU admission rate and duration SGA, and perinatal deaths in women with severe PE and HELLP syndrome compared to those with severe PE alone.

The prospective design with properly calculated sample size is the main strengths of our trial and could be a base for creation of an easy and low-cost risk score for women with severe PE for detection of maternal and fetal/neonatal complications. Most important clinical, laboratory and ultrasonographic detectors were assessed properly allowing the detection of high-risk women for complications especially in limited resource countries.

The main limitations of this trial were the limited sample size and inability to complete long-term follow-up of the neonates. Moreover, only the limited study population characteristic diversity was used to establish the reference ranges & cutoff values. Studies from different areas with different population characteristics are warranted for the

possibility of loco-regional differences in the normal range and build up an area based reference ranges to be followed if it differs from our published values.

DECLARATIONS

-Ethics approval and consent to participate the study was approved by kasr Alainy ethical committee on 4th of April 2020 number MD-184-2019. The study was conducted in accordance with the Declaration of Helsinki.
- All participants signed an informed written consent to participate.

-Consent for publication:

Not Applicable

-Availability of data and materials:

All data are available with the corresponding author can be supplied upon reasonable request

-Competing interests: None

-Funding: None**Authors' contribution**

MAS project development, follow up, revision, and approval of manuscript

BE data collection, data analysis, writing, revision, and approval of manuscript

WE participants supervision, revision, and approval of manuscript

NE data analysis, writing, revision, and approval of manuscript

AMM Project development, supervision, writing, revision and approval of manuscript

NS Data analysis, follow up, revision and approval of manuscript

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HIGHLIGHTS

UA Doppler had significantly higher resistance in women with complicated severe PE.

UA Doppler had significantly higher resistance in women who needed ICU admission UA Doppler had significantly higher resistance in women whose neonates needed ICU admission suffering from TTN or RDS

UA Doppler had significantly higher resistance in women with neonatal perinatal deaths.

REFERENCES

1. Gestational Hypertension and Preeclampsia: ACOG Practice Bulletin, Number 222. Obstet Gynecol. 2020 Jun;135(6): e237-e260. doi: 10.1097/AOG.0000000000003891. PMID: 32443079.
2. Sharma D D, Chandresh N R, Javed A, et al. The Management of Preeclampsia: A Comprehensive Review of Current Practices and Future Directions. Cureus 2024; 16(1): e51512. DOI 10.7759/cureus.51512
3. Lin S, Shimizu I, Suehara N, Nakayama M, Aono T: Uterine artery Doppler velocimetry in relation to trophoblast migration into the myometrium of the placental bed. Obstet Gynecol. 1995855, 1:760-5. 10.1016/0029-7844(95)00020-r
4. Tomimatsu T, Mimura K, Matsuzaki S, Endo M, Kumasawa K, Kimura T: Preeclampsia: maternal systemic vascular disorder caused by generalized endothelial dysfunction due to placental antiangiogenic factors. Int J Mol Sci. 2019, 20:4246. 10.3390/ijms20174246
5. Global and regional causes of maternal deaths 2009–20: a WHO systematic analysis. Lancet Glob Health. 2025.
6. Cunningham FG, Leveno KJ, Bloom SL, Dashe JS, Hoffman BL, Casey BM, Spong CY. Hypertensive Disorders. In: Williams Obstetrics. 26th ed. New York: McGraw-Hill Education; 2022. p. 711–730.
7. Karabay, G.; Bayraktar, B.; Seyhanli, Z.; Filiz, A.A.; Tokgoz Cakir, B.; Aktemur, G.; Tonyali, N.V.; Agaoglu, R.T.; Kocaoglu, G.; Karabay, U.; et al. Evaluation of Conventional and Combined Doppler Parameters in Preeclampsia: Diagnostic and Prognostic Insights. J. Clin. Med. 2025, 14, 647. https://doi.org/10.3390/jcm14020647
8. El-Demiry, N. M., Maged, A. M., Gaafar, H. M., ElAnwary, S., Shaltout, A., Ibrahim, S., … Elsherbini, M. M. The value of fetal Doppler indices as predictors of perinatal outcome in women with preeclampsia with severe features. Hypertension in Pregnancy 2020; 39(2), 95–102. https://doi.org/10.1080/10641955.2020.1732406
9. American College of Obstetricians and Gynecologists, ACOG. Emergent therapy for acute-onset, severe hypertension during pregnancy and the postpartum period. Committee opinion no. 692. Obstet Gynecol. 2017;129: e90–5.
10. Core D, Zoorob D, Maxwell R, Catalanotto Maas M, Hixson Richardson E, Fucinari D, Menefee C, Landry L, Barrilleaux P. Umbilical Artery Doppler and Adverse Outcomes in Severe Preeclampsia Without Fetal Growth Restriction: A Retrospective Cohort Study. Cureus. 2024 Aug 26;16(8): e67850. doi: 10.7759/cureus.67850. PMID: 39193058; PMCID: PMC11348823.
11. Zhang Z, Liu F, Zhang Q, Li D, Cai L. Umbilical artery ultrasound haemodynamics combined with serum adiponectin levels can aid in predicting adverse pregnancy outcomes in patients with severe pre-eclampsia. J Obstet Gynaecol. 2023 Dec;43(2):2232656. doi: 10.1080/01443615.2023.2232656. PMID: 37462393.
12. Maged AM, Elsherief A, Hassan H, Salaheldin D, Omran KA, Almohamady M, Dahab S, Fahmy R, AbdelHak A, Shoab AY, Lotfy R, Lasheen YS, Nabil H, Elbaradie SMY. Maternal, fetal, and neonatal outcomes among different types of hypertensive disorders associating pregnancy needing intensive care management. J Matern Fetal Neonatal Med. 2020 Jan;33(2):314-321. doi: 10.1080/14767058.2018.1491030.