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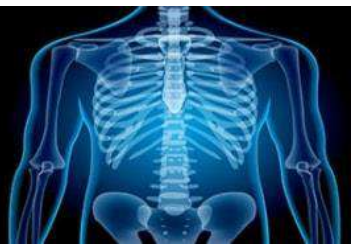

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Role of uterine and umbilical artery Doppler in prediction of developing pre- eclampsia in pregnancy

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Abstract
Background: Pre-eclampsia (PE) in pregnancy remains a crucial public health menace in both developed and developing countries contributing to maternal and perinatal morbidity and mortality. It complicates about 2%–10% of pregnancies globally, affecting about ten million women with about 76,000 maternal deaths annually from complications of PE and related hypertensive disorders.[4] The incidence of PE is seven times higher in developing countries where severe PE and eclampsia are more common and seen in 4% of all deliveries in some parts but up to 18% in other parts of Africa.
Methodology: It is a longitudinal cohort study, in which we have evaluated the uterine and umbilical arteries and pregnancy outcomes in PE cases using several Doppler ultrasound parameters and their combinations determined Doppler parameters that best predict PE. Singleton pregnancies registered or referred to the hospital over a period of an year were monitored. The ethical clearance was obtained by the ethical committee.
Results: The pregnant women were grouped into two groups: 65 women who developed PE with or without other pregnancy complications and 30 pregnant women who did not develop PE. Among the pregnant women that developed PE, 20 had mild PE and 45 had severe PE. The mean age of pregnant women who developed PE was 31.03 ± 3.11 years with a range of 22–39 years, while the mean age of pregnant women who did not develop PE was 30.65 ± 5.20 years with a range of 15–48.
Conclusion: The findings of our study show that the PSV and EDV were significantly lower, whereas the RI, PI and S/D were significantly higher in cases that developed PE. The uterine artery PI is the best predictor of PE. A combination of the uterine artery PSV and the umbilical artery PSV best predict severity of PE among pregnant women.

Keywords: Doppler Ultrasound, Uterine Pulsatility Index, Uterine Artery, Neonatal Morbidity

Introduction
Pre-eclampsia (PE) is a pregnancy-related hypertensive disorder which is usually seen after 20 weeks of gestation in affected women, it could be a continuum in pregnancy-induced hypertension (PIH) [1]. It remains a crucial public health menace in both developed and developing countries contributing to maternal and perinatal morbidity and mortality [2]. It complicates about 2%–10% of pregnancies globally [2, 3], affecting about ten million women with about 76,000 maternal deaths annually from complications of PE and related hypertensive disorders [4]. The incidence of PE is seven times higher in developing countries [5], where severe PE and eclampsia are more common and seen in 4% of all deliveries in some parts but up to 18% in other parts of Africa [6]. About 10%–25% of those cases end in maternal deaths [7]. Prevalence of PE [8]. o 9/100 deliveries [9, 10], with a rising trend within the incidence over the years [11]. Eclampsia may have a dramatic, abrupt onset and in many ladies with none warning signs/symptoms [12, 13]. Untreated PE progresses to eclampsia when convulsions occur additionally to hypertension in pregnancy and proteinuria [2]. It's answerable for about 12%–25% of foetal growth restriction, small for age (GA) infants and about 15%–20% of all pre-term births; with severe long-term prematurity-related neonatal morbidity and deaths [5]. Doppler analysis is a useful method for prediction of PE and its adverse outcomes related with the pregnancy [14, 15 16], The arteria blood flow represents the maternal haemodynamic status, and increased arteria PI and RI documented to be related to increased risk of PE [17, 18]. Increased Uterine Pulsatility Index (PI) and Resistance Index (RI) are related to an increased risk for PE [19, 20]. The aim of the present study is to find out the role of uterine and umbilical artery doppler in prediction of developing pre- eclampsia.

Materials and methods

It is a longitudinal cohort study, in which we have evaluated the uterine and umbilical arteries and pregnancy outcomes in PE cases using several Doppler ultrasound parameters and their combinations determined Doppler parameters that best predict PE. Singleton pregnancies registered or referred to the hospital over a period of an year were monitored. The ethical clearance was obtained by the ethical committee. Total 100 cases were included in the study. Participation in this study was completely voluntary and based on written informed consent after explanation of the intentions and purpose of the study. All data were analysed using the IBM SPSS Statistical version 23.0 and frequency distributions were generated with appropriate graphs and tables. Qualitative variables were compared using Chi‐ square test and reported by proportions. Quantitative variables between the two groups were compared using Student's t‐ test, with level significance set at 0.05. While one-way analysis of variance was used to compare between more than two groups.

Results

This prospective study was done among 100 pregnant women with high risk pregnancies (HRP), five were lost to follow‐ up, whereas 95 delivered at our hospital. The Pregnant women were grouped into two groups: 65 women who developed PE with or without other pregnancy complications and 30 pregnant women who did not develop PE. Among the pregnant women that developed PE, 20 had mild PE and 45 had severe PE. The mean age of pregnant women who developed PE was 31.03 ± 3.11 years with a range of 22–39 years, while the mean age of pregnant women who did not develop PE was 30.65 ± 5.20 years with a range of 15–48. There was no significant difference in the age between the two groups (table-1) Table 2 shows 33.4% normal delieveries, 64.6% c- sections, 89.6% term delieveries,9.4% preterm delieveries, 99% live births and 0% still death took place in our study. In the umbilical arteries, the mean umbilical PSV of pregnant women who had mild PE (M = 44.58 cm/s, SD = 12.03) was significantly higher than that of women who developed severe PE (M = 34.48 cm/s, SD = 12.95) (P = 0.046) [Table 4]. Other Doppler parameters; uterine PSV, RI and PI though slightly higher in those with severe PE; slightly higher umbilical RI, PI and S/D, but decreased EDV in severe PE were not statistically significant as shown in [Table 4]. There was also a statistically significant association between PE and neonatal complications, of low birth weight deliveries were from women with severe PE, mild PE and participant without PE [Table 5].

Table 1: Characteristics of study population

Patient parameters	No PE group	PE group	P
Age, mean ±(SD)	30.65 (±5.20)	31.03 (±3.11)	0.721
Weight, mean ±(SD)	72.90 (±16.93)	65.80 (±10.55)	0.271
Height, mean ±(SD)	1.61 (±0.08)	1.60 (±0.04)	0.830
Systolic BP, mean ±(SD)	113.0 (±12.66)	161.2 (±30.93)	<0.001
Diastolic BP, mean ±(SD)	66.33 (±6.76)	96.65 (±20.44)	<0.001

Table 2: Parity in study population

Parity	Number of cases	Percentages	P
Nulliparous	16 (52.1)	19 (31.8)	0.136
Primiparous	6 (20.9)	2 (35.7)	
Multiparous	7 (25.0)	17 (28.5)	
Delivery Outcomes			
Normal delivery SVD	10 (33.4)	10 (17.0)	0.116
Caesarian section	20 (64.6)	46 (76.0)	
Abortion	0 (0.0)	3 (4.9)	
Term delivery	28 (89.6)	18 (31.8)	<0.001
Preterm delivery	4 (9.4)	38 (66.2)	
Livebirth	31 (99.0)	53 (92.1)	0.128
Still birth	0 (0.00)	4 (5.8)	

Table 3: Doppler parameters among non‐ pre‐ eclampsia and pre‐ eclampsia high‐ risk pregnancy cohort

Doppler parameters	Non−PE group, mean±SD	PE group, mean±SD	95% CI for mean difference	*t*	df	*P*
Uterine artery						
Mean uterine PSV (cm/s)	63.10±21.72	61.22±19.11	−5.73‐ 12.78	0.633	85	0.462
Mean uterine EDV (cm/s)	33.96±12.44	24.97±13.01	3.10-16.51	3.012	84	0.002
Mean uterine RI	0.40±0.12	0.56±0.12	−0.12‐ −0.01	−2.165	83	0.002
Mean uterine PI	0.73±0.26	1.36±0.47	−0.66‐ −0.36	−6.420	71	<0.001
Mean uterine S/D	1.91±0.40	2.77±1.00	−1.21‐ −0.60	−5.660	80	<0.001
Umbilical artery						
Mean umbilical PSV (cm/s)	43.59±5.03	36.46±14.15	1.14-11.50	2.347	80	0.016
Mean umbilical EDV (cm/s)	21.23±6.67	14.48±7.42	0.90-8.52	2.2249	75	0.017
Mean umbilical RI	0.47±0.11	0.62±0.13	−0.12‐ −0.011	−2.06	76	0.017
Mean umbilical PI	0.86±0.21	1.12±0.46	−0.32‐ −0.10	−3.404	68	0.002
Mean umbilical S/D	2.40±0.57	2.94±1.13	−0.94‐ −0.083	−2.361	74	0.010

Table 4: Severity of pre‐ eclampsia and Doppler parameters

	PE absent, mean±SD	PE present, mean±SD	95% CI for mean difference	*t*	df	*P*
Uterine artery						
Mean uterine PSV (cm/s)	63.10±22.62	60.12±19.14	−5.65‐ 12.42	0.731	84	0.446
Mean uterine EDV (cm/s)	33.96±12.44	24.97±12.01	3.20-12.51	3.022	83	0.002
Mean uterine RI	0.40±0.12	0.56±0.12	−0.14‐ −0.02	−3.145	84	0.001
Mean uterine PI	0.45±0.26	1.34±0.47	−0.82‐ −0.43	−6.420	70	<0.001
Mean uterine S/D ratio	1.91±0.40	2.69±1.02	−1.22‐ −0.60	−5.840	80	<0.001
Umbilical artery						
Mean umbilical PSV (cm/s)	44.58±12.03	34.48±14.16	1.24-13.50	2.297	80	0.018
Mean umbilical EDV (cm/s)	20.23±7.67	15.58±8.423	0.61-8.52	2.2449	75	0.015
Mean umbilical RI	0.56±0.12	0.64±0.12	−0.13‐ −0.022	−2.207	77	0.018
Mean umbilical PI	0.84±0.10	1.12±0.42	−0.41‐ −0.10	−3.426	66	0.001
Mean umbilical S/D	2.21±0.54	2.85±1.12	−0.86‐ −0.024	−2.362	77	0.020

Table 5: Delivery outcomes among the no pre‐ eclampsia and the pre‐ eclampsia group

Delivery outcomes	No PE	Mild PE	Severe PE	$\chi 2$	*P*
Delivery mode*					
SVD	2(51.0)	2(14.2)	6 (31.4)	5.162	0.211
Caesarean section	21(30.3)	16 (21.5)	31(25.4)		
Abortion	0(0.0)	0 (01.0)	3 (100.0)		
Term delivery	28(60.4)	6 (14.7)	1(21.9)	28.344	<0.001
Preterm delivery	2(6.1)	11 (27.6)	26 (62.3)		
Neonatal complication*					
No complication	20(56.3)	6 (20.2)	6(19.4)	35.179	<0.001
LBW	3(9.3)	11 (24.9)	25 (61.8)		
Others	2(100.0)	0 (0.0)	0 (0.0)		
Birth type* Still birth	0(0.0)	0(0.0)	2(100.0)	4.121	0.143

Discussion

Several studies have reported the numerous proportion of occurrence of PE among high-risk pregnant women [2]. During this study, about 62.2% of girls with HRP had PE with or without other complications. Severe PE (72.5%) was more common among women with PE, in agreement with Liu *et al.*'s findings [21] among 412 Taiwanese with gestational hypertensive disorders; severe PE was seen in 88.3% of the PE cases. In contrast, Lopez-Mendez *et al.*, [22]. among 102 hP Mexican women studied, reported severe PE in 41.5% among the PE cases. Likewise, Myatt *et al* [23]. reported 40.0% of severe PE cases among PE cases studied. However, both studies had a younger PE population compared to the present study. Studies have shown that older age patients is additionally more at risk of severe PE [24, 25] and this, additionally to the actual fact that PE is more common in developing countries [26], might account for the high proportion during this study and differences observed. During this study, the blood pressure (P < 0.001) and DBP (P < 0.001) were significantly different in women who had PE with or without other pregnancy complication and folks who haven't got PE. There was no significant difference in age and between women who had PE and ladies without PE, discrepant with Liu *et al.* [21] report during which age additionally to systolic and DBP showed significant difference among eclampsia cases and controls. Again this difference is additionally due to the patient selection criteria of eclampsia cases employed in their study compared with PE cases during this study. Our observation of decreased blood flow velocities, particularly the EDV but increased impedance indices (RI, PI and S/D) in both the uterine and umbilical arteries in women that developed PE compared with people that didn't in agreement with Barati et al.'s documentation of increased diastolic flow velocities in normal pregnancies [27]. While decreased flow velocities and high resistance/impedance indices are seen in PE [27]. In line with our study, the significantly higher mean artery S/D ratio, RI and PI among PE cases compared to women without PE, support the report by Mallikarjunappa *et al.* [28] that the uterine and umbilical artery Doppler study showed elevation of these three parameters among pregnant women with PE within the second and trimester. This was also corroborated by Li *et al.*'s [29] report. In contrast, Lopez-Mendez *et al.* [22] observed no significant difference within the uterine arteries' PI and RI, but reported an enormous difference within the umbilical artery PI and RI between HRP women with PE and folks without PE, which is akin to our findings within the umbilical arteries within the current study. The difference between end during this current study and thus the study above is also because of differences in population dynamics and thus the abnormality limits of obstetric Doppler parameters which may differ between populations [21]. Previous researchers have reported different findings on the Doppler parameter that best predict PE among high-risk patients. These include, [30] increased PI and thus the presence of early diastolic notch, [31] and abnormal artery PI values of >1.45 and/or the presence of bilateral diastolic notch [27]. However, Li *et al.* [29] noted that the diastolic notch isn't commonly seen and present only in about 25% of cases within the trimester. in line with Nagar *et al.*, [32] the mixture of uterine and umbilical arteries Doppler parameters better predicts PE than artery findings alone. In our evaluation of the numerous combinations of the uterine and umbilical arteries Doppler parameters that best predict PE during this study, we observed that the artery PI alone best predict PE. The systematic review and bivariable meta-analysis of the utilization of artery Doppler ultrasonography to predict PE and intra-uterine growth restriction by Cnossen *et al.* [31] is also because of difference in study methodology [21]. The actual fact that none of the

studies considered by Cnoseen et al [31]. was from a native African population, is also a heavy factor, bearing in mind the actual fact that the population dynamics and Doppler abnormality limits differ from one population to a distinct [21]. Furthermore, Doppler ultrasound was performed in about 61% of the population within the trimester during this study compared to 18 and 24 weeks' gestation in most of the studies reviewed by Cnossen *et al.*, [31].

Conclusion

The findings of our study show that the PSV and EDV were significantly lower, whereas the RI, PI and S/D were significantly higher in cases that developed PE. The uterine artery PI is the best predictor of PE. A combination of the uterine artery PSV and the umbilical artery PSV best predict severity of PE among pregnant women.

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