CLINICAL ARTICLE

Third-trimester uterine artery Doppler measurement and maternal postpartum outcome among patients with severe pre-eclampsia

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ABSTRACT

Objective: To evaluate the association between uterine artery Doppler measurements and maternal complications among women with severe pre-eclampsia. *Methods:* As part of a cross-sectional study, women with a single intrauterine pregnancy of more than 28 weeks and a diagnosis of severe pre-eclampsia were enrolled at a unit in Cairo, Egypt, between December 2012 and September 2014. Uterine artery Doppler was evaluated and maternal complications were recorded. *Results:* Among the 100 participants, 76 (76%) experienced maternal complications. There were significant differences in resistance index (RI) and pulsatility index (PI) between women who experienced no complications and those who had accidental hemorrhage, HELLP syndrome, and acute pulmonary edema ($P < 0.001$ for all), and postpartum hemorrhage ($P = 0.004$ and $P < 0.001$, respectively). There was no significant difference in RI for women with postpartum fits ($P = 0.360$). There was a statistically significant difference regarding RI ($P < 0.001$) and PI ($P = 0.005$) between cases presenting with complications and those without. There was a significant negative correlation between PI and gestational age ($r = -0.988$; $P < 0.001$) and between RI and gestational age ($r = -0.854$; $P < 0.001$), but no significant correlation between PI or RI and age, systolic blood pressure, or diastolic blood pressure. *Conclusion:* Increased uterine artery resistance in the third trimester of pregnancy could be used to predict postpartum maternal complications.

1. Introduction

Pre-eclampsia is a pregnancy-specific syndrome that affects multiple organ systems [1]. Although it is more complex than simply gestational hypertension with proteinuria, the appearance of proteinuria remains an important and objective diagnostic criterion [2]. Pre-eclampsia often affects young and nulliparous women, whereas older women are at greater risk of chronic hypertension with superimposed pre-eclampsia [3]. Furthermore, the incidence of the disorder is markedly influenced by race and ethnic origin, and environmental, socioeconomic, and even seasonal factors [3]. Between 3% and 10% of nulliparous women are affected; the prevalence is lower among multiparas [4].

Pre-eclampsia is associated with a high rate of maternal and perinatal morbidity and mortality. Affected women can develop eclampsia, acute pulmonary edema, cerebral vascular accidents, and renal and/or liver failure [5]. Pre-eclampsia is a frequent indication for admission to obstetric intensive care units (ICUs) as well as a cause of prolonged hospitalization [6].

The physiopathology of pre-eclampsia is believed to be poor placentation [7]. Previous reports have described the disruption of endothelial junctional proteins [8], subendothelial ultrastructural changes in resistance arteries [9], and abnormal trophoblastic invasion and generalized vessel spasms [10]. Therefore, the uterine arteries could have high resistance. The only known cure for pre-eclampsia is placental delivery [11], after which the affected organ systems return to their original state following vasospastic relief. Indeed, the role of vasoconstriction in pre-eclampsia has been well established [7] and could explain several of the complications associated with this condition [12]. Because the persistence of bilateral early diastolic notching of the uterine artery is a result of systemic vasospasms, a greater frequency of complications could be expected in women in whom Doppler velocimetry has shown the maternal compartment to be affected.

The aim of the present study was to evaluate the association between uterine artery Doppler velocimetry indices and the frequency of maternal postpartum complications among women with severe pre-eclampsia.

2. Materials and methods

A descriptive, observational, cross-sectional study was undertaken at Kasr Al-Ainy Hospital Emergency Unit in Cairo, Egypt, between December 1, 2012, and September 30, 2014. Patients with a single intrauterine pregnancy of more than 28 weeks and a diagnosis of severe pre-eclampsia were enrolled. Women with multiple pregnancies, a history of chronic hypertension, gestational diabetes, diabetes mellitus, or autoimmune diseases were excluded, as were women with uterine

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activity, intrauterine fetal death on admission, or clinical emergencies with maternal hemodynamic instability or an indication for immediate termination of pregnancy. The study was approved by the local ethics committee. Informed consent was obtained from all participants.

The diagnosis criteria for severe pre-eclampsia were proteinuria of more than 300 mg/mL and high systolic blood pressure (SBP; >160 mm Hg) and diastolic blood pressure (DBP; >110 mmHg), or a lower SBP (>140 mmHg) and DBP (>90 mmHg) associated with other symptoms (e.g. a persistent headache, gastrointestinal manifestations [vomiting], or abnormal vision). The absence of hypertension before pregnancy and before 20 weeks of pregnancy was mandatory for diagnosis [13].

Study data were retrieved from patient and attendant interviews, patient obstetric medical records, and referral letters in cases referred from other health facilities. The data obtained from all women included age, gravidity, parity, date of last normal menstrual period (to estimate gestational age), a full medical history, and details of symptoms such as headache, visual disturbances, epigastric pain, edema, oliguria, or convulsions (timing and number). A full physical examination was performed. Blood pressure was measured using a mercury sphygmomanometer with appropriate size cuffs using the first (systolic) and fifth (diastolic) Korotkoff sounds. Laboratory examinations were undertaken, including complete blood count, liver function tests (aspartate transaminase, alanine transaminase, and prothrombin activity), kidney function tests (urea and creatinine), and blood group assessment. Urine samples were tested for proteinuria using the dipstick method.

Transabdominal obstetric ultrasound examination was performed using a Medison X6 machine (Medison Co, Seoul, South Korea) equipped with a 4–7 MHz transabdominal probe (3D4-7EK) for confirmation of fetal number, viability, presentation, estimated fetal weight, position and grade of placenta, amount of liquor, detailed anomaly scan, biophysical profile, and gestational age through measurements of the biparietal diameter, head circumference, abdominal circumference, and femur length.

Uterine artery Doppler velocimetry was performed with the Medison X6 ultrasound scanner at the crossover of the uterine and external iliac arteries with an insonation angle of less than 30°, a velocity of more than 60 cm/s, and a sample volume of 2.0 mm. Both sides were measured three times and the mean results were recorded. The pulsatility index (PI) was calculated using the equation PI = (peak systolic velocity–end diastolic velocity)/time averaged velocity. The resistance index (RI) was calculated using the equation RI = (peak systolic velocity–end diastolic velocity)/peak systolic velocity.

Management modalities included nursing care, control of convulsions using intravenous $MgSO_4$ (6 g given intravenously over 20 minutes as a loading dose, followed by an intravenous infusion at a rate of 1 g/hour for 24 hours, with clinical assessments every 4 hours), control of hypertension (20 mg hydralazine diluted in 10 mL saline given every 15 minutes until a DBP of <100 mm Hg was reached), and obstetric care (termination of pregnancy either by induction of labor or through surgical interference by cesarean delivery). Women were continuously monitored in the eclampsia ward until they were ambulant and stable.

Continuous data were expressed as means (with standard deviations) or number (percentage). Categorical data were presented in the form of number and percentage. For statistical comparisons, participants were divided by whether they presented with symptoms and by whether they experienced complications. Comparisons between groups (symptoms vs no symptoms, and complications vs no complications) using the Student unpaired t-test. Comparison between categorical data was performed using the χ^2 test. The Pearson correlation coefficient was used to determine significant correlations among different parameters. A receiver operating characteristic curve was used to determine the sensitivity and specificity of endometrial volume. The data were considered significant if P values were equal to or lower than 0.05 and highly significant if P values were lower than 0.01. All statistical calculations were performed using SPSS version 15 (SPSS Inc, Chicago, IL, USA) for Microsoft Windows.

3. Results

A total of 100 women diagnosed with severe pre-eclampsia were included in the present study. Among the 100 participants, 71 (71%) presented with symptoms. The most common presenting symptoms were headache, eclamptic fits, and epigastric pain (Table 1). Overall, 76 (76%) women experienced complications, but no maternal deaths were recorded. The most common maternal complication was postpartum fits (Table 1). The most common fetal/neonatal complications were neonatal ICU admission and stillbirth (Table 1).

There was a statistically significant difference in the RI between women without symptoms and women with fits, blurring of vision, or coma ($P < 0.001$ for all), but there were no statistically significant differences in those with headaches ($P = 0.630$) or epigastric pain ($P = 0.511$) (Table 2). Significant differences in PI were observed between women without symptoms and women with fits, blurring of vision, or coma ($P < 0.001$ for all), as well as those with headaches ($P = 0.003$); there was no significant difference in those presenting with epigastric pain ($P = 0.246$) (Table 2).

Table 1
Characteristics and outcomes.

Characteristic/outcome	Participants (n = 100)[a]
Age, y	
<20	36 (36)
20–35	46 (46)
>35	18 (18)
Gestational age, wk	
28–36	24 (24)
>36	76 (76)
Presenting symptoms	
Headache	40 (40)
Fits	40 (40)
Epigastric pain	36 (36)
Blurring of vision	18 (18)
Coma	4 (4)
Laboratory findings	
Low platelets[b]	12 (12)
Decreased prothrombin time[c]	8 (8)
Elevated alanine transaminase[d]	24 (24)
Elevated aspartate transaminase[e]	30 (30)
Elevated urea[f]	30 (30)
Elevated creatinine[g]	16 (16)
Maternal complications	
Postpartum fits	24 (24)
Accidental hemorrhage	12 (12)
Postpartum hemorrhage	12 (12)
HELLP syndrome[h]	8 (8)
Acute pulmonary edema	8 (8)
Renal failure	2 (2)
None	24 (24)
Fetal/neonatal complications	
NICU admission	46 (46)
Stillbirth	26 (26)
Neonatal death	14 (14)
None	14 (14)
Body mass index[i]	27.2 ± 3.5
Proteinuria, mg/dL	3.4 ± 0.9

Abbreviation: NICU, neonatal intensive care unit.
[a] Values are given as number (percentage) or mean ± SD.
[b] $<150 \times 10^3$/mL.
[c] <11.4 s.
[d] >30 U/L.
[e] >30 U/L.
[f] >6.43 mmol/L.
[g] >106.08 μmol/L.
[h] Hemolysis, elevated liver enzymes, and low platelet count.
[i] Calculated as weight in kilograms divided by the square of height in meters.