International Journal of Clinical Obstetrics and Gynaecology

ISSN (P): 2522-6614
ISSN (E): 2522-6622

www.gynaecologyjournal.com
2023; 7(2): 245-248
Received: 25-01-2023
Accepted: 05-03-2023

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First trimester 3D ultrasound placental volume at 11th to 13th weeks gestational age for predicting preeclampsia

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DOI: https://doi.org/10.33545/gynae.2023.v7.i2d.1313

Abstract
Background: After the 20th week of pregnancy, preeclampsia is diagnosed when a woman develops new-onset hypertension (systolic blood pressure 140 mm Hg or higher, or diastolic blood pressure 90 mm Hg or higher) and proteinuria (300 mg or more in a 24-hour urine collection, or 1+ on dipstick testing). The aim of this work was to determine the sensitivity of placental volume (PV) in the first trimester at 11th week to 13th week+6 days in predicting preeclampsia.
Methods: This prospective observational study was carried out on 250 women with any gravidity, singleton pregnancy between 11th to 13th week of gestation based on the last menstrual period or first-trimester ultrasound. All patients were subjected to laboratory investigations (CBC, Renal function tests, Random blood sugar and tests to detect proteinuria.) and imaging.
Results: The sensitivity and specificity of PV in differentiating between preeclampsia and normotensive were 60.0%; 60.0% respectively. There was high significant difference in between preeclmpesia and normotensive cases regarding to PV.
Conclusions: The PV was lower in cases with preeclampsia as compared to nonpreeclamptic women with highly significant statistical difference and that means 3D PV measurement at 11th to 13th week of pregnancy could increase the predictive accuracy for pre-eclampsia.

Keywords: First trimester, 3D ultrasound, placental volume, gestational age, preeclampsia

Introduction
Preeclampsia, a multisystem complications of pregnancy, affects 2-8% of pregnancies and is a major contributor to mother and fetal morbidity and mortality [1].
Proteinuria (300 mg or more in a 24-h urine collection or 1+ on dipstick testing) and new-onset hypertension (systolic blood pressure 140 mm Hg or higher or diastolic blood pressure 90 mm Hg or higher) after 20 weeks of gestation are the diagnostic criteria for preeclampsia [2]. Age-related vascular endothelial deterioration or atherosclerotic occlusion of the maternal spiral arteriolar lumen may contribute to the rising incidence of preeclampsia in pregnant women. Maternal and fetal mortality and morbidity can be decreased through preeclampsia detection and the early identification of high-risk pregnant mothers [3].
Since the placenta is responsible for transporting oxygen and nutrients to the developing fetus, abnormal placentation during the first trimester may be a major factor in determining the likelihood of developing late pregnancy complications [4].
Inadequate placentation causes preeclampsia and intrauterine growth restriction (IUGR). In addition, the size and form of the placenta upon delivery are highly predictive of the infant's weight at birth. In early pregnancy, the development of 3D ultrasonography has allowed for more accurate and reliable determination of placental volume (PV) [5].
While uterine perfusion reflects trophoblast invasion later in pregnancy, PV may do so much earlier in pregnancy. In example, hypertension and IUGR have been linked to the prediction of a decreased early PV [6].
Preeclampsia has been predicted in the past by measuring PV with 3D ultrasonography in the first trimester [6, 7].
Another investigation concluded that PV is unreliable for early prediction of either gestational hypertension or IUGR [7].

First trimester screening for early and late preeclampsia will employ PV in conjunction with maternal features and biomarkers. The predicted PV will have limited application in this study, however.

The aim of this work was to determine the sensitivity of PV in the first trimester at 11th week to 13th week+6 days in predicting preeclampsia.

Patients and Methods

This prospective observational study was carried out on 250 women with any gravidity, singleton pregnancy between 11th to 13th week of gestation based on the last menstrual period or first-trimester ultrasound.

The Ethical Committee of Tanta University Hospitals gave their approval to the project. Patients gave their signed consent after receiving all detailed information.

Exclusion criteria were women with a fetal structural abnormality, multiple pregnancy, using aspirin, and medical diseases (esp. antiphospholipid syndrome, hypertension and DM). All patients were subjected to history taking, clinical examination, laboratory investigations (CBC, Renal function tests, Random blood sugar and tests to detect proteinuria.) and imaging.

Imaging

Three-dimensional ultrasound was done for all the patients with Samsung H60 South Korean manufacturer which is an electronic sector transducer with a frequency of 3.5-5 MHz to measure PV.

A perpendicular line was drawn with a sweep angle of 85 degrees to the placental plate. After that, we employed the VOCAL method to get six successive slices of the placenta, each one rotated by 30 degrees from the one before it. The placental contour was manually traced in each of the six planes, with special attention paid to avoiding the uterine wall, which is typically thicker under the placenta at this stage of gestation due to hypertrophy or contraction.

The software determined the total volume by summing the highlighted regions across all six views.

Sample size

Sample size 250

Statistical analysis

SPSS (Statistical Package for the Social Sciences) for Windows® (SPSS Inc, Chicago, IL, USA) was used for all statistical analyses. When applicable, data was statistically described using Mean SD, median, or frequencies (number of cases) and percentages. The McNemar test was used to compare the means of the groups' numerical variables. Kappa test was used to determine level of agreement. For statistical significance, a p value of less than 0.05 was used.

Results

This study included 250 women; 11were missed during follow up and 8 miscarried.

Only 231completed the study successfully.

Table 1 shows demographic data of the studied cases as regard blood investigation, blood pressure results and placental volume results distribution among studied cases.

Table 1: Demographic data of the studied cases as regard blood investigation, blood pressure results and placental volume results distribution among studied cases

Laboratory investigations	n = 250
RDW %	14.13±1.16
WBCs (10^3/UL)	8.68±2.5
MPV (fl)	9.14±1.56
HB (gm/dl)	11.32±0.86
Renal function	
Serum creatinine	0.69±0.26
RBS (mg/dl)	97.05±15.53
Blood pressure	
Systolic blood pressure (mm/Hg)	108.2±10.1
Diastolic blood pressure (mm/Hg)	71.9±7.58
Placental volume (cm3)	53.4 ± 8.5

Data are presented as mean ± SD, RDW: Red Blood Cell Distribution Width, WBCs: white blood cells, MPV: Mean platelet volume, HB: Haemoglobin, RBS: Random Blood Sugar.

There was no significant difference between the preeclampsia and noemotensive cases as regard to age, and BMI. There were 17.3% of pre-eclampesia cases and 0% of normotensive cases had Previous history of pre-eclampesia with a significant difference in between. There was high significant difference in between preeclampsia and normotensive women regarding to placental volume. Table 2

Table 2: Demographic characteristics data and mean placental volume among the studied cases during follow up

Variables	N=231		
	Pre-eclampesia N=17	normotensive N=214	P value
Age (y)	27.57±4.3	26.64±2.6	P = 0.113
BMI (Kg/m^2)	30.75±2.25	30.37±3.25	P = 0.163
Previous history of preeclampsia	4(17.3%)	0(0%)	P = 0.634
Placental volume (cm^3)	43.4 ± 6.4	50.6 ± 9.4	P = 0.034*

Data are presented as mean ± SD or frequency (%), BMI: Body mass index

There was no significant difference in between the studied cases regarding any of the examined laboratory investigations. Table 3

Table 3: Comparison of laboratory investigations between studied cases

Laboratory investigations	Pre-eclampsia N=17	Normotensive N=214	P value
RDW %	14.39±1.02	14.02±1.2	p=0.14
Hb	11.33±1.03	11.24±1.52	P = 0.469
WBCs (10^3/UL)	8.32±1.99	8.84±2.7	p=0.35
MPV (fl)	9.04±1.2	9.18±1.7	p=0.68
Serum creatinine	0.89±0.12	0.81±0.26	p=0.75
RBS (mg/dl)	98.6±14.2	96.39±16.13	p=0.52

Data are presented as mean ± SD, RDW: Red Blood Cell Distribution Width, WBCs: white blood cells, MPV: Mean platelet volume, HB: Haemoglobin, RBS: Random Blood Sugar.
The sensitivity and specificity of placental volume in differentiating between pre-eclampsia and normotensive were 60.0%; 60.0% respectively. Figure 1

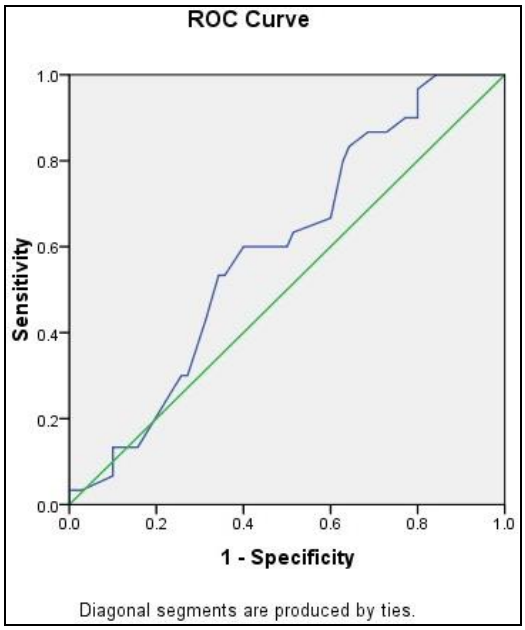

Fig 1: ROC curve for in Placental volume (cm3) differentiating pre-eclampesia cases from normotensive cases.

Discussion

Pre-eclampsia, and notably early-onset pre-eclampsia, develops during the first 12 weeks of pregnancy, with trophoblast invasion and remodelling of the spiral arteries (39).
In the current study, there were 17 female (6.8%) developed pre-eclampsia which agree with the study done by Abdallah *et al*., 2021 (44) among 2019 women, only 163 women (8.1%) developed pre-eclampsia and that difference may be due to the difference in number of the studied cases.
Also, Ali *et al*., [8] in their study of 50 pregnant women found that, 22% developed preeclampsia and 78% did not develop preeclampsia.
Regarding to age, the mean age in the current study was 27.57±4.3 in pre-eclampesia cases and 26.64±2.6 in normotensive cases with no difference in between which agree with Abdallah *et al*., [9] who found that the mean age was 24.75 ± 5.85 in pre-eclampesia group and 24.53 ± 5.78 in normotensive group with no significant difference in between
Also, Ali *et al*., [8] in their study found that the mean age in was 31.36 ± 4.95in preeclampsia cases and 29.31 ± 6.13in normotensive cases.
In our study, there were 17.3% of pre-eclampesia cases and 0% of normotensive cases had Previous history of pre-eclampesia with a significant difference in between which agree with the study done by Abdallah *et al*., 2021 [9] who found that (35.5%) of Pre-eclampsia group and (19.9%) of Normotensive group had Previous history of pre-eclampsia with a significant difference in between.
In this study, the placental volume (PV) in preeclampsia group was lower than that of nonpreeclampsia group with a statistical difference in between which in agreement with Our findings corroborated those of Abdallah *et al*. [9], who found that, when comparing women with and without pre-eclampsia, those with pre-eclampsia had considerably smaller PVs ($p \leq 0.007$).
On the other side, Dündar *et al*. [10] looked at how PV between weeks 11 and 13 of pregnancy correlates with subsequent pre-eclampsia occurrence. In this study, researchers discovered minimal variations in PV between the pre-eclamptic and normal groups. Pre-eclampsia cannot be reliably predicted from PV alone for these reasons. PV may be of use, nevertheless, when considered alongside other factors.
Since most markers for predicting preeclampsia in the first trimester had low sensitivity and specificity, the results confirmed that these markers could only predict preeclampsia in its earliest stages [11].
PV has been shown to be unreliable in the past for predicting preeclampsia and hypertension or IUGR in pregnancy [7].
Pregnancy outcomes may be improved with a more personalized, patient- and disease-specific approach to antenatal care if risks for these issues are estimated early on and action is taken to reduce them. Accordingly, a new method of antenatal care at about 11- to 13-week can be approached [12].
In the present study, the sensitivity of PV to detect preeclampsia was 60% which disagree with the study done by Soongsatitanon *et al*. 2019 [5] the sensitivity of a low PV in predicting preeclampsia (27.3%) was lower than in previous studies [13].
In another study done in Turkey by, Yucel *et al*. [13] employed the same PV cut-off as our study, but found that low PV only had a sensitivity of 53.6% in predicting preeclampsia. It's possible that the ethnic diversity of the research populations accounts for the variance.
In this study, the area under the curve was0.593 with no significant value of PV in prediction of preeclampsia which agree with Ali *et al*., [8] who found that the area under the curve was 0.638 with no significant value of PV in prediction of preeclampsia We also find agreement with the findings of Odibo *et al*. [14] The ROC curve for the prediction of preeclampsia in their study which includes 388 women between 11th and 14th week carrying a single baby was 0.71.
First trimester alterations in PV and vascular markers are not limited to preeclampsia. Plasencia *et al*., [12] previously observed that PV was a predictor of small- or large-for-GA newborns. Plasencia *et al*. [15] Whether or not the pregnant woman with the SGA baby develop preeclampsia, the results show that PV was drastically reduced in the first trimester. Based on the study's results, the following are recommended: Further research is needed for understanding the nature of PV role in prediction of preeclampsia in early pregnancy.

Conclusions

There was a highly significant statistical difference between preeclamptic and non-preeclamptic women in terms of placental volume. and that means 3D placental volume measurement at 11th to 13th week of pregnancy could increase the predictive accuracy for preeclampsia.

Financial support and sponsorship: Nil

Conflict of Interest: Nil

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How to Cite This Article

Ahmed AA, Elnamory MM, Osman AM, Aglan DM. First trimester 3D ultrasound placental volume at 11th to 13th weeks gestational age for predicting preeclampsia. International Journal of Clinical Obstetrics and Gynaecology. Yy;vol(issue):pp.