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Accuracy of Second Trimester Prediction of Preterm Preeclampsia by Three Different Screening Algorithms

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ABSTRACT

Background: Preeclampsia is a condition unique to pregnancy, which can lead to significant maternal and fetal morbidity and death. Early detection of women at greater risk of preeclampsia helps avoid and treat early illness.
Aim of the work: current study aimed to compare the performance of the NICE guidelines, the ACOG recommendations and (FMF) algorithm for the early detection of preeclampsia.
Patients and Methods: Current study was a cohort prospective study included 400 women who attended for their routine antenatal care during the second trimester. All demographic and clinical data and follow up cases collected.
Results: The incidence of preeclampsia was 9.3%. There was a significant older age (28.89±2.74 vs 27.55±2.88) and increase in patient weight, height and BMI among PE cases. Also, there was a statistical significant raising in the cesarean section mode of delivery (45.9% vs 26.4%), ovulation induction (24.3% vs 6.1%) and high mean of arterial pressure (113.46±2.34 vs 92.09±2.98 mmHg), and Doppler ultrasound, the uterine artery pulsatility index (PI) (1.05±0.30 vs 0.55±0.14) among PE cases. On the other hand, there was a statistical significant decrease in fetal GA at delivery (37.0±1.49 vs 38.19±1.10 weeks), decrease of fetal birth weight, Apgar score at first and fifth minutes among females developed PE.
Conclusion: Screening for early preeclampsia in second trimester using maternal history, mean arterial pressure and mean uterine artery Doppler pulsatility index (FMF algorithm) was better than screening by maternal characteristics alone (NICE and ACOG guidelines).

Keywords: *Preeclampsia; Preterm; Hypertension; Screening.*

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INTRODUCTION

A common complication of pregnancy is hypertensive disorders, which place women and their fetuses at disproportionate risk of more complications, as well as lifelong sequelae.[1] Preeclampsia (PE) is a disease occurred after 20 week gestation characterized by hypertension greater than 140/90 mmHg in pregnancy and proteinuria more than 0.3 g/24 h.[2] Preeclampsia affects 5 to 7 percent of all pregnant women with the highest morbidity and mortality; it causes more than 70,000 mothers death and 500,000 fetal deaths worldwide per year.[3] After 16 weeks there is also more than 50% of women in their first antenatal visit and in developed countries as many as 88.5%, where the prevention of illness risks is also a big challenge.[4]

Early monitoring in the first trimester helps the introduction of early preventative measures such as low-dose aspirin treatment initiated before 16 weeks of gestation in patients at high risk of PE.[5] Screening for PE can also be useful during the second trimester as close observation of early signs of PE enables timely treatment and delivery. Moreover, research suggests that women undergoing PE have an elevated life-long risk of cardiovascular disease, which, in essence, may facilitate the adoption of postnatal preventive measures by associating with occurrence and gestational age at the beginning of PE.[6] Various ways of research in various healthcare facilities have been recommended and used. Many of these approaches are focused on socioeconomic, medical and obstetric considerations, etc.[7]

The present study aimed to compare NICE guidance, ACOG advice, the Fetal Medicine Foundation (FMF) and Multi-Marker Patient Risk Assessment for the Second Trimester of Pregnancy in 19-22 weeks to predict preeclampsia, using maternal history, mean arterial pressure (MAP), and uterine artery Doppler (PI) mean.

PATIENTS AND METHODS

The current study was a cohort prospective study included 400 Women who attended for their routine antenatal care during second trimester between 19 and 22 weeks' gestation.

The inclusion criteria were primi-gravida and singleton pregnancies. Exclusion criteria included Family history of hypertension (HTN), multiple gestations and chronic medical diseases; (chronic hypertension, diabetes mellitus (DM), hyperthyroidism, anti-phospholipids syndrome (APS), thrombophilia, sickle cell disease) and In-vitro fertilization (IVF).

Maternal age, cigarette smoking during pregnancy, medical history (including DM, chronic hypertension, thrombophilia, APS and sickle cell disease), conception approaches (spontaneous, induction of ovulation or IVF), parity and family history of PE.

The measured and estimated maternal weight and height; Often, after two tests in each arm, the mean blood pressure (MAP) is measured. The woman should be seated, the arms are supported at heart, and the handles are tiny (< 22 cm), medium (22–32 cm) or broad (33–42 cm); the blood pressure is supported by validated automated devices; We have measured the MAP for each arm on average for the past two constant measurements; for subsequent outcomes review, we are going to take the arm with the highest final MAP.

Color Doppler used for calculating the left and right uterine artery pulsatility indices (PI) and average values. The recommendations of NICE, ACOG and FMF algorithms will then be graded in each patient as high or low risk of pre-eclampsia (PE).

Outcomes of the pregnancies had been determined. Fetal birth weight was estimated. The newborn considered SGA if the birth weight is less than the 10th percentile.

A sample size of 400 women selected using software of Epi Info 2000a special formula based on the prevalence of preeclampsia at a confidence interval of 95% and precision of (2%).

Ethical consideration

The study procedures performed under the ethical standards of the Helsinki declaration. It is approved by a research ethics committee at Faculty of Medicine - Al-Azhar University. Before distributing the questionnaire, the studied population informed about the objectives of the study, and the confidentiality of their information. The participants accepted to enroll were very voluntarily and fulfilled a written consent.

Data analysis performed using the Statistical Package of Social Science (SPSS) software version 22 in windows 7. Quantitative data first tested for normality distributed by the One-Sample Kolmogorov-Smirnov test. In-depended student t-Test used in comparing measures between two independent quantitative groups. Regards qualitative data Chi Square used. Sensitivity and specificity test for testing a new test with ROC curve "Receiver Operating Characteristic". Cutoff value was < 0.05 for significance.

RESULTS

The study included 400 women; the mean age was (27.6 ±2.9) years old ranged between 20 and 35 years old. As regards anthropometric measurement, the mean weight was (69.4 ± 4.3) kg, mean height was (1.66 ± 0.030) m, and mean BMI was (25.18±1.12) kg/m^2. Among study group the incidence of preeclampsia was 37 (9.3%). For the mode of delivery 287 (71.8%) delivered normal vaginal mode, versus 113 (28.3%) delivered by cesarean section CS. The routine visits gestational age mean was (10.54± 0.9) week, and at delivery was (38.08 ± 1.19) weeks. For clinical examination of the mother, the mean arterial blood pressure was (94.07± 6.86) mm Hg, and mean uterine artery plasticity index was (0.6±0.21). For the fetus, the mean fetal birth weight of (3025.82 ± 231.55) gm with mean Apgar-1 was (8.16±0.72) and Apgar-5 was (9.45±0.50).

There was a statistical significant difference in age, anthropometric measurements, conception type and mode of delivery between females developed PE when compared to those did not develop PE with p-value <0.05. PE patients were older in age, a higher mean weight, height, and BMI, in addition to a higher percentage of ovulation induction, and cesarean section mode of delivered noticed among PE patients. (Table 1).

Variables	PE (N=37)		No PE (N=363)		Test	P-value
	Mean	SD	Mean	SD	T	
Age (years)	28.89	2.74	27.55	2.88	2.70	0.007*
Anthropometric measures						
Weight (kg)	74.81	7.65	68.81	3.36	8.81	<0.001*
Height (m)	1.67	0.035	1.66	0.030	2.11	0.035*
BMI (kg/m^2)	26.79	1.95	25.01	0.85	10.31	<0.001*
Conception	No.	%	No.	%	X^2	P-value
Spontaneous	28	75.7%	341	93.9%	15.66	<0.001*
Ovulation induction	9	24.3%	22	6.1%		
Mode of delivery	No.	%	No.	%		
NVD	20	54.1%	267	73.6%	6.30	0.012*
CS	17	45.9%	96	26.4%		

Table 1: Comparisons of demographic characters in different study groups.

There was a statistically significant higher mean of arterial blood pressure and mean Uterine artery plasticity index, and lower delivery gestational age

mean, fetal birth weight, and Apgar score after first and fifth minutes with p-value <0.05 among cases with PE. However, there is no statistically significant difference regarding gestational age at routine visits. (Table 2).

Variables	PE (N=37)		No PE (N=363)		T-Test	P-value
	Mean	SD	Mean	SD		
Mean arterial pressure (MAP)	113.46	2.34	92.09	2.98	42.23	<0.001*
Uterine artery plasticity index (UA-PI)	1.05	0.30	0.55	0.14	18.17	<0.001*
Fetal assessment						
Gestational age at routine visits (w)	10.54	0.97	10.54	0.90	0.16	0.73
Gestational age (GA) at delivery	37.00	1.49	38.19	1.10	6.02	<0.001*
Fetal birth weight (gm)	2741.35	322.36	3054.82	199.12	8.51	<0.001*
Apgar-1	7.24	0.83	8.25	0.65	8.77	<0.001*
Apgar-5	9.10	0.45	9.49	0.50	4.45	<0.001*

Table 2: Comparisons of clinical assessment for women and fetuses in different study groups.

There was a statistically significant higher percentage of risky to develop PE when assessed by NICE, ACOG, and FMF scores among PE cases, with high accuracy in detection of PE cases by FMF score (91.1%), followed by the ACOG score (81.1%) and lowest accuracy was found by the NICE score (48.6%). (Table 3)

Variables	PE (N=37)		No PE (N=363)		X^2	P-value
	No.	%	No.	%		
NICE score						
Risky	18	48.6%	10	2.8%	108.6	<0.001*
No Risky	19	51.4%	353	97.2%		
ACOG score						
Risky	30	81.1%	7	1.9%	250	<0.001*
No Risky	7	18.9%	356	98.1%		
FMF score						
Risky	34	91.9%	4	1.1 %	321	<0.001*
No Risky	3	8.1%	359	98.9%		

Table 3: Comparisons of guideline score outcomes in different study groups.

For NICE guidelines score, the area under the curve was 72%; the sensitivity for diagnosis of preeclampsia was 48.6%, and specificity was 93.0%. (Figure 1) For ACOG guidelines score, the area under the curve was 89%; the sensitivity for diagnosis of preeclampsia was 81.1%, and specificity was 98.1 %. (Figure 2) For FMF score, the area under the curve was 95%; the sensitivity for diagnosis of preeclampsia was 91.1%, and specificity was 98.9%. (Figure 3) Therefore, the FMF score shows the highest level of accuracy, sensitivity and specificity than NICE, and ACGO scores. (Table 4).

Variable	Sensitivity	Specificity	+ve predictive	-ve predictive	Accuracy	AUC
NICE score	48.6%	93%	64.28%	98.89%	92.8%	72%
ACOG score	81.1%	98.1%	81.1%	98.1%	96.5%	89%
FMF score	91.1%	98.9%	89.47%	99.2%	98.25%	95%

Table 4: Sensitivity and specificity of each NICE, ACOG, and FMF scores in diagnosis of Preeclampsia

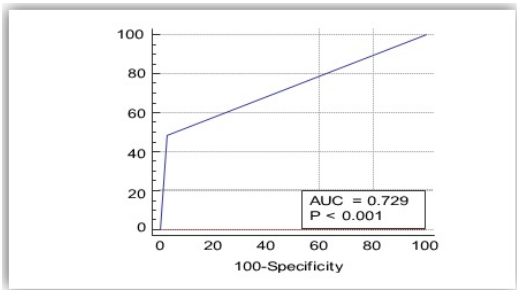

Fig. 1: ROC curve for NICE guidelines for diagnosis of preeclampsia

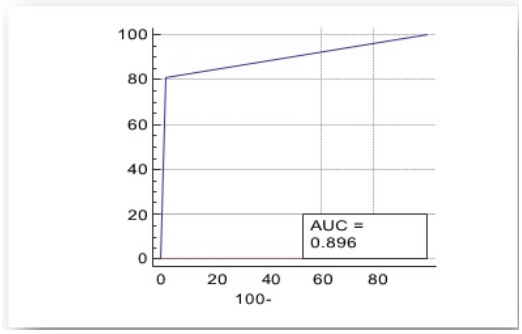

Fig. 2: ROC curve analysis for ACOG score in diagnosis of preeclampsia

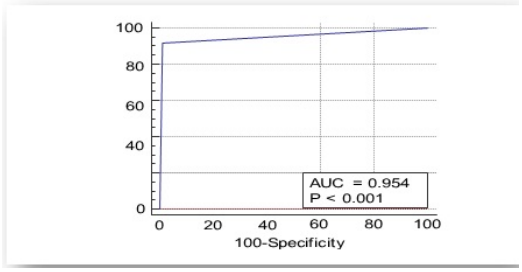

Fig. 3: ROC curve analysis for FMF score in diagnosis of preeclampsia

DISCUSSION

Preeclampsia (PE) is a significant cause of maternal and perinatal morbidity and mortality, affecting from 2-8 percent of all births.[8]

In the first trimester, preventive steps required women to be detected at great risk.[5] The multivariable algorithms for preeclampsia have shown better efficiency in the last decade than the conventional maternal history screening technique alone.[9]

In the present work, the incidence of preeclampsia was 9.3%; this was in agreement with American study who found that preeclampsia represent 9.1% of the study group.[10]

There was significant increase in age of females developed PE. Similar findings reported in the Australian study.[8]

In the present work, there was a statistical significant decrease in fetal birth weight, and Apgar score at the first and fifth minutes among females who developed PE when compared to those who did not develop PE. Similar findings reported in Iranian study that Apgar scores at the 1st and 5th minute in high-risk group were lower than that in the low risk group.[11]

Regards the mode of delivery, there was a higher percentage of cesarean section among females who developed PE. In contrary to our study, American study found that normal vaginal delivery (NVD) was higher than cesarean section among females developed preeclampsia.[10] But it was in agreement with two studies results, which found a significant increase of CS among PE females when compared to females without PE.[12, 13]

Current study reported that there was a significant decrease of GA at delivery among females with PE. Preeclampsia could be early preterm onset when diagnosed before 34 week gestation, late preterm onset if diagnosed from 34 to 37 weeks, and term onset when diagnosed at or beyond 37 weeks.[14]

There was a significant increase in the U.A PI among PE when compared to those with No PE females. An abnormal measures of uterine artery velocity in the studied women is comparatively at higher risk of preeclampsia.[15] In preeclampsia, the incomplete trophoblast invaded the uterine artery and replaces the endothelial and the muscular lining of blood vessels then cause increase vascular diameter, and leads to an increase in uterine artery resistance.[16]

There was a significant increase in the mean arterial pressure among PE when compared to no PE groups. In agreement with our study, study conducted by Al-Amin et al.[8] Along Similarity, to our study, in the normal blood pressure group, an increase of 5.2% was observed, compared to 13.3% in the preeclampsia late-onset group.[17]

In the present work, there was a statistical significant increase in patient weight, height and BMI in patients who developed PE. Studies conducted in Canada, and China found that high weight gain was more strongly associated with later-onset preeclampsia.[18,19] In contrast; the Generation R cohort from the Netherlands, Pennsylvania and Iceland found no significant association between pregnancy weight gain and preeclampsia.[20, 21, 22]

Among studied females, there was a significant increase of ovulation induction among patients who developed PE, these results similar to the prospective study of obstetric outcomes stated that ovulation induction is associated with increased risk of preeclampsia.[23, 24]

CONCLUSION

Different clinical risk factors in early weeks of pregnancy raise a woman's risk of preeclampsia. In addition to the rise in MAP and mean uterine artery Doppler PI, weight gain, ovulation induction and age had an effect. Fetus to PE mother demonstrates low gestational age, low fetal weight and low Apgar score at the first and fifth minutes.

FMF score showed higher accuracy in detection of PE, followed by ACOG score and the lowest accuracy found in NICE score. For early diagnosis and timely management of preeclampsia and to prevent its complications, maternal characteristics should not be used alone to identify women at high risk of pre-eclampsia .

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