

Original Research Article

Comparison of gestosis score vs uterine artery pulsatility index in predicting hypertensive disorders of pregnancy: a prospective observational study

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ABSTRACT

Background: Hypertensive disorders of pregnancy include conditions such as gestational hypertension, pre-eclampsia, and severe pre-eclampsia. Early prediction and management of these hypertensive disorders are therefore essential to improve health outcomes and reduce pregnancy-related complications. This study aims to compare the predictive performance of the gestosis score and uterine artery pulsatility index for hypertensive disorder of pregnancy, and to evaluate the individual effectiveness of each tool in predicting the severity of these disorders.

Methods: This prospective observational study included 140 pregnant women at 11 to 14 weeks. Participants were stratified into risk groups based on their gestosis score. The uterine artery PI was measured using doppler ultrasound and mean uterine artery PI > 95th percentile was classified as high risk. Participants were followed up till delivery to record the occurrence of hypertensive disorders of pregnancy.

Results: Hypertensive disorders of pregnancy affected 34% of participants, with gestational hypertension in 16.4%, preeclampsia in 15.7%, and severe preeclampsia in 2.1%. The gestosis score classified 67.2% study participants as high risk, while uterine artery PI > 95th percentile was noted in 37.1% pregnant women. The gestosis score demonstrated a sensitivity of 85.4% and specificity of 75.0% for hypertensive disorders of pregnancy (AUC 0.855), with 91.3% sensitivity for gestational hypertension and 77.2% sensitivity for preeclampsia, and 100% for severe preeclampsia. Uterine artery PI showed a sensitivity of 77.1% and specificity of 83.7% for hypertensive disorders of pregnancy (AUC 0.765), with 91.3% sensitivity for gestational hypertension, 63.6% for preeclampsia, and 66.7% for severe preeclampsia.

Conclusions: The gestosis score, owing to its high sensitivity is a valuable screening tool for HDOP in resource-limited settings. In contrast, UtA-PI offers superior diagnostic accuracy with balanced sensitivity and specificity, making it an effective non-invasive Doppler marker.

Keywords: Gestosis score, Uterine artery pulsatility index, Hypertensive disorder of pregnancy, Gestational hypertension, Preeclampsia

INTRODUCTION

Hypertensive disorders are the most common medical problems encountered by women during pregnancy with wide-ranging implications for maternal and fetal health.¹ In India, the pooled prevalence of hypertensive disorders of pregnancy is approximately 9% (95% CI, 8%–10%), a

figure significantly higher than the global prevalence, underscoring the public health relevance of effective screening and management in the Indian population.² Gestational hypertension, as defined by the American College of Obstetrics and Gynaecology (ACOG), is a systolic blood pressure of 140 mmHg or greater or a diastolic blood pressure of 90 mmHg or greater on two

separate measurements at least four hours apart after 20 weeks of gestation in women who were previously normotensive.³ When hypertension is accompanied by proteinuria, the condition is referred to as pre-eclampsia (PE), a potentially severe complication that can lead to adverse maternal and fetal outcomes. Gestational hypertension and pre-eclampsia represent major concerns in obstetric practice, given their impact on maternal and perinatal health, with risks of preterm delivery, fetal growth restriction, and, in severe cases, maternal organ failure or eclampsia.^{4,5} Federation of Obstetrics and Gynaecological Society (FIGO) encourages resource-appropriate testing for prediction of pre-eclampsia in routine first-trimester evaluation at all maternal health services.⁶ Range of predictive multiparametric algorithms has been developed to predict hypertensive disorders of pregnancy and implement preventive strategies. These algorithms incorporate a combination of maternal risk factors, radiological evaluations like the uterine artery doppler, and plasma biomarkers, providing a multi-dimensional approach to risk prediction. Although these algorithms have demonstrated considerable efficacy in identifying high-risk women, the variability in clinical application remains a challenge, and predictive models for gestational hypertension and preeclampsia have yet to achieve routine implementation in clinical practice.⁷

One such tool to identify women at high risk of developing hypertensive disorders of pregnancy is gestosis score, which systematically evaluates established and emerging risk factors for gestational hypertension and assigns weighted scores (1, 2, or 3) to each clinical factor based on its relative contribution to disease development. This score is derived from comprehensive clinical evaluation and detailed patient history, enabling cumulative risk stratification. Women with a total score of 1 are categorized as low risk, those with a score of 2 as moderate risk, and with a score of 3 or more as high risk for developing hypertensive disorder of pregnancy.⁸

In addition to clinical risk scoring, uterine artery doppler velocimetry serves as a non-invasive modality for evaluating the risk of hypertensive disorders in pregnancy.⁹ This assessment measures the pulsatility index (PI) of both uterine arteries, using transabdominal ultrasound approach. The mean PI is then calculated, and women with values above the 95th percentile for their gestational age are classified as high risk, whereas those with values below this threshold are considered low risk.

Doppler ultrasound findings have been associated with adverse pregnancy outcomes, particularly in women exhibiting elevated pulsatility indices, which reflect increased uteroplacental vascular resistance and compromised placental perfusion. Recent advances in Doppler ultrasonography have enhanced the accuracy and reproducibility of this measurement, thereby increasing its utility as a predictive tool for hypertensive disorder of pregnancy.¹⁰

Women classified as high risk based on the gestosis score and uterine artery PI can be monitored more closely, with frequent blood pressure checks and pharmacological interventions where necessary for timely intervention and individualized care. Recent clinical trials show that early intervention in high-risk pregnancies significantly reduces the incidence of hypertensive disorder of pregnancy and associated complications, including preterm birth and low birth weight.¹¹ Both the gestosis score and uterine artery PI show independent predictive potential, but direct comparative studies are scarce. This study, therefore, aims to compare the predictive accuracy of the gestosis score and the uterine artery PI in identifying pregnancies at risk for hypertensive disorder of pregnancy. By determining the comparative effectiveness of these tools, the study seeks to identify an efficient, low-cost method that can be widely adopted, especially in settings where advanced diagnostic technologies are not readily available.

METHODS

Study design and setting

This study is a hospital based prospective observational study, conducted from December 2023 to November 2024 at Tata Main Hospital, Jamshedpur, India, a tertiary care hospital with comprehensive maternal and child healthcare services.

Study population

Pregnant women attending the antenatal clinic were the source population for this study.

Inclusion criteria

Pregnant women with gestational age between 11 to 14 weeks who were willing to follow up till delivery were included in this study.

Exclusion criteria

Pregnant women with gestational age above 14 weeks, having non-viable pregnancy and who did not give informed consent for participation were excluded from the study.

Sample size calculation

The required sample size was calculated using the formula below.

$$N = \frac{Z^2 P(1-P)}{d^2}$$

where N is required sample size, Z is 1.96 (for a 95% confidence level), P is estimated prevalence of gestational hypertension =9%, d is desired margin of error=5% or 0.05. To account for potential attrition (10%), the target enrolment was set at 140 participants.

Sampling technique

This study employed consecutive sampling, with all eligible participants presenting during the study period being enrolled in succession until the desired sample size was reached.

Operational definitions

Hypertensive disorders of pregnancy

It comprises gestational hypertension, preeclampsia, and severe preeclampsia.

Gestational hypertension

Defined as new-onset hypertension (systolic BP $\geq$ 140 mmHg and/or diastolic BP $\geq$ 90 mmHg) after 20 weeks of gestation in the absence of proteinuria.

Pre-eclampsia

Defined as new-onset hypertension (systolic BP $\geq$ 140 mmHg and/or diastolic BP $\geq$ 90 mmHg) after 20 weeks of gestation with proteinuria.

Severe preeclampsia: preeclampsia with severe features.

Gestosis score

A risk assessment score used to predict hypertensive disorder of pregnancy.

Uterine artery PI

A Doppler ultrasound measurement indicating blood flow resistance in the uterine arteries.

Methodology

All the 27 parameters of gestosis score were recorded at 11–14 weeks and scores were calculated. Based on the gestosis score assessed, participants were categorized into low, moderate, and high-risk groups. A score of one indicated low risk, a score of two indicated moderate risk, and a score of three or more indicated high risk. A calibrated Doppler ultrasound device (GE VOLUSON P8) was used to measure the uterine artery PI. Uterine artery Doppler examinations were performed by multiple trained sonologists following a standardized first trimester Doppler protocol. The sample volume was placed at the ascending branch of the uterine artery near the internal cervical os, the angle of isonation was kept below 30 degrees, and at least three consecutive similar waveforms were obtained before measuring the PI. The mean of the right and left uterine artery PI values was used for analysis. Values above the 95th percentile were classified as high risk, while values below the 95th percentile were categorized as low risk, based on gestation age-specific uterine artery PI percentile cut-offs. Blood pressure was

measured using a standardized sphygmomanometer during each antenatal visit. Participants were followed prospectively through routine antenatal visits to ascertain the development of gestational hypertension or preeclampsia and related outcomes. A structured proforma was used to record demographic details, gestosis scores, ultrasound findings, and blood pressure measurements. Data were collected at baseline (11–14 weeks) and during each antenatal visit.

Data management and analysis plan

Data were entered into Microsoft Excel and checked for accuracy. Continuous variables were summarized as mean and standard deviation (SD) and categorical variables were summarized as frequencies and percentages. Comparison of continuous variables with outcome variables was performed using a student's t-test or Mann-Whitney U test, depending on the distribution of the data. Comparison of categorical variables was performed using the Chi-square test. Statistical significance was defined as $p < 0.05$. Data were analysed using SPSS version 21.0 (SPSS, Chicago, IL, USA). ROC curve analysis was performed to evaluate the predictive performance of the gestosis score and uterine artery PI for hypertensive disorders of pregnancy. The area under the ROC curve (AUC) with 95% confidence intervals (CI) was calculated for each predictor. ROC analysis was also used to determine optimal cutoff values. Diagnostic performance indices, including sensitivity, specificity, positive predictive value (PPV), negative predictive value, were calculated with their corresponding 95% confidence interval.

Ethical consideration

The study protocol was submitted for review and approval to the Institutional Ethics Committee at Tata Main Hospital, Jamshedpur, and the research proceeded only after obtaining formal approval vide letter no. TMH/IEC/NOV/107/2023 dated 29th November 2023.

RESULTS

The prevalence of various comorbidities and risk factors among the study participants is presented in Table 1. The most common conditions observed were elevated mean arterial pressure (MAP $>$ 85) in 65% of pregnant women, primigravida status in 62.8%, anaemia in 32.1%, and hypothyroidism in 30%. Other notable conditions included short cohabitation (28.6%), polycystic ovarian disease (15%), and gestational diabetes mellitus (14.2%).

Certain conditions, such as dyslipidaemia, excessive weight gain, and thrombophilia, were not reported among any participants. Based on the gestosis score, most pregnant women (67.2%) were classified as high risk, whereas 16.4% each were categorized as moderate risk and low risk (Table 2).

Table 3 represents the prevalence of uterine artery PI above the 95th percentile among participants. Overall,

37.1% of participants had uterine artery PI>95%, whereas 62.9 % had values within the normal range. Out of the 140 pregnant women studied, 48 (38.2%) developed hypertensive disorders of pregnancy. Among them, 23 were diagnosed with gestational hypertension, 22 with preeclampsia and 03 with severe preeclampsia (Table 4).

Table 5 summarizes the diagnostic performance of two predictors high-risk gestosis score (≥ 3) and elevated uterine artery PI (>95th percentile) in detecting various hypertensive disorders in pregnancy.

Table 1: Descriptive table for co-morbidities among participants (n=140).

Co-morbidity /risk factors	Present	Absent
Age >35 years	16	124
Age <19 years	1	139
Maternal anaemia	45	95
Body mass index >30	13	127
Primigravida	88	52
Short cohabitation	40	100
Women born as small for gestation	15	125
Family history of cardiovascular diseases	11	129
Polycystic ovarian disease	21	119
Inter pregnancy interval >7 years	09	131
Artificial reproductive technique	10	130
Dyslipidaemia	00	140
Mean arterial pressure >85 mm Hg	91	49
Excess weight gain	00	14
Hypothyroidism	42	98
Family history of preeclampsia	07	133
Gestational diabetes	20	120
Body mass index >35	01	139
Multifetal pregnancy	10	130
HDOP during previous pregnancy	06	134
Pregestational diabetes	02	138
Chronic hypertension	04	136
Mental disorder	00	140
Thrombophilia	00	140
Chronic kidney disease	00	140
Autoimmune disease (SLE/APLAs/RA)	01	139
Ovum donation/surrogacy	00	140

Table 2: Descriptive table for risk category based on gestosis score.

Risk category (based on gestosis score)	Number of participants (n=140)	Percentage (%)
Low risk	23	16.4
Moderate risk	23	6.4
High risk	94	67.2

Table 3: Descriptive table for uterine artery PI>95th percentile.

Uterine artery PI>95 th percentile	Number of participants (N)	Percentage (%)
Yes	52	37.1
No	88	62.9

Table 4: Distribution of hypertensive disorders of pregnancy cohort.

HDOP	Total number (n=48)	Percentage (%)
Gestational HTN	23	16.4
Preeclampsia	22	15.7
Severe preeclampsia	3	2.1

Table 5: Predictability parameters with gestosis score against uterine artery-PI.

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic accuracy (%)
Predictability parameters for HDOP					
Gestosis score (high risk)	85.40	75.00	64.10	90.80	78.60
Uterine artery PI>95 th percentile	77.10	83.70	71.10	87.50	81.40
Predictability parameters for gestational hypertension					
Gestosis score (high risk)	91.30	62.40	32.30	97.30	67.10
Uterine artery PI>95 th percentile	91.30	73.50	40.40	97.70	76.40
Predictability parameters for preeclampsia					
Gestosis score (high risk)	77.20	59.30	26.20	93.30	62.10
Uterine artery PI>95 th percentile	63.60	67.80	26.90	90.90	67.10
Predictability parameters for severe preeclampsia					
Gestosis score (high risk)	100.00	54.70	4.60	100.00	55.70
Uterine artery PI>95 th percentile	66.7	63.5	3.80	98.90	63.60

DISCUSSION

This study aimed to compare the predictive ability of the gestosis score and uterine artery PI in identifying women at risk of developing hypertensive disorders of pregnancy, with a secondary objective of evaluating the individual effectiveness of each tool in predicting hypertensive disorders of pregnancy. Among the 140 pregnant women included in study, 34.2% (n=48) developed hypertensive disorders of pregnancy, comprising 16.2% (n=23) with gestational hypertension, 15.7% (n=22) with preeclampsia and 2.1% (n=3) with severe preeclampsia. These prevalence rates are comparable to those reported by Gupta et al (15.01% for preeclampsia) although the observed variations may be attributed to difference in population risk profiles and diagnostic criteria.¹² The substantial prevalence of elevated MAP (65%) reinforces its utility as an early predictive marker for hypertensive disorders of pregnancy, corroborating the observations made by Razzak et al.¹³

The primary objective was addressed by comparing the predictive performance of the gestosis score and the uterine artery PI in identifying hypertensive disorders of pregnancy. A gestosis score of ≥ 3 identified 67.2% (n=94) of participants as high risk, of whom 64.6% (n=42) subsequently developed hypertensive disorders of pregnancy. The tool demonstrated a sensitivity of 85.4%, specificity of 75.0%, PPV of 64.1%, NPV of 90.8%, and a diagnostic accuracy of 78.6%, indicating good overall predictive performance.

In contrast, uterine artery PI>95th percentile was observed in 37.1% (n=52) of participants, of whom 71.1% (n=37) subsequently developed hypertensive disorders of pregnancy. This yielded a sensitivity of 77.1%, specificity of 83.7%, PPV of 71.1%, NPV of 87.5%, and diagnostic accuracy of 81.4%. Receiver operating characteristics (ROC) analysis further supported these findings, with an area under the curve (AUC) of 0.855 for gestosis score and 0.765 for uterine artery PI, indicating superior overall

discriminatory ability of the gestosis score in predicting HDOP (Figure 1).

For gestational hypertension, both predictors demonstrated high sensitivity (91.3%); however, the uterine artery PI outperformed the gestosis score in terms of specificity (73.5% vs. 62.4%) and diagnostic accuracy (76.4% vs. 67.1%). The AUC values were modest (0.595 for gestosis score and 0.619 for UtA-PI), suggesting limited discriminatory power of both predictors for gestational hypertension alone (Figure 2).

In predicting preeclampsia, the gestosis score demonstrated higher sensitivity (77.2% vs. 63.6%) but lower specificity (59.3% vs. 67.8%) and diagnostic accuracy (62.1% vs. 67.1%) compared to the uterine artery PI. However, the uterine artery PI demonstrated a higher AUC (0.889 vs. 0.740), indicating superior overall predictive performance for preeclampsia (Figure 3). For severe PE, both tools demonstrated very low sensitivity (4.6% for the gestosis score and 4.0% for the UtA-PI) but high specificity (100.0% and 98.9%) respectively.

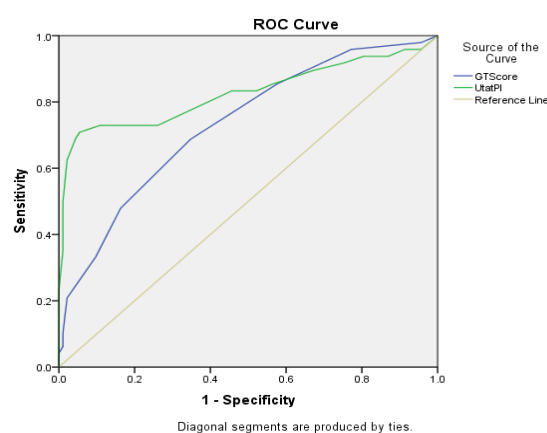


Figure 1: ROC of hypertensive disorders of pregnancy with gestosis score and uterine artery PI. [AUC (gestosis score) – 0.855, AUC (uterine artery PI)- 0.765].

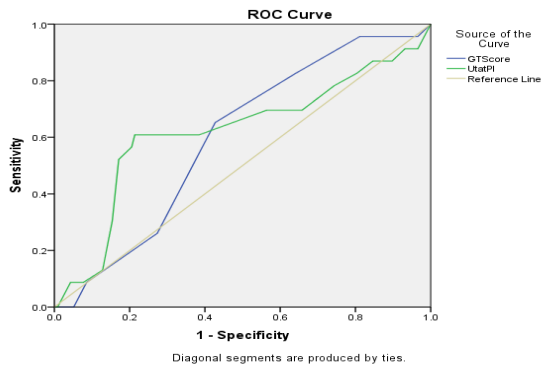


Figure 2: ROC of gestational hypertension with gestosis score and uterine artery PI [AUC (gestosis score) -0.595, AUC (uterine artery PI) -0.619].

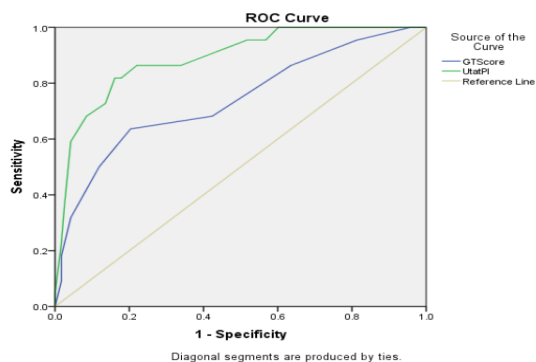


Figure 3: ROC for preeclampsia with gestosis score and uterine artery PI [AUC (gestosis score) -0.740, AUC (UtA-PI) -0.889]

The AUC values were 0.855 and 0.765, respectively (Figure 4). Despite relatively good AUC values, the extremely low sensitivity suggests limited clinical utility in detecting severe PE, likely due to its low incidence in the study population. These findings are consistent with previous research.

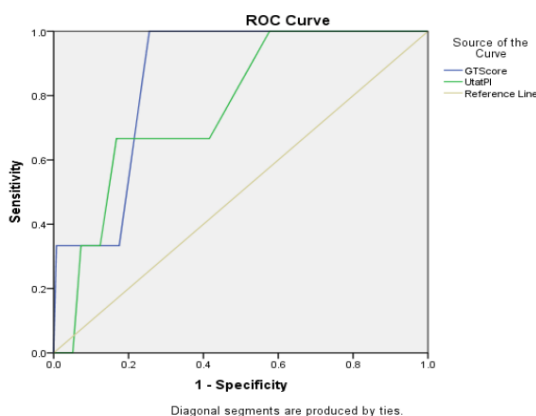


Figure 4: ROC for Severe PE with gestosis score and uterine artery PI [AUC (gestosis score) - 0.855, AUC (Uterine artery PI) - 0.765].

Gupta et al reported a sensitivity of 83.1% and specificity of 97.51% for gestosis score in predicting PE, while Khanijo et al observed a sensitivity of 84.38% and specificity of 93.18%.^{12,14} Both studies demonstrated higher diagnostic performance compared to our results. This discrepancy may be attributed to differences in scoring thresholds, variations in study populations, sample size, and baseline risk profiles. Kopuk et al had highlighted the value of uterine artery PI in predicting preeclampsia.¹⁵ They reported a sensitivity of 42.31% and specificity of 82.10% at a cut-off of >2.23, which is lower than the sensitivity observed in our study. This difference may be attributed to variations in gestational age at assessment, chosen cut-off values, and population characteristics.

The secondary objectives evaluated the individual effectiveness of each tool in predicting different forms of hypertensive disorders of pregnancy. The gestosis score demonstrated high sensitivity (85.4% for overall hypertensive disorder of pregnancy, 91.3% for gestational hypertension, 77.2% for preeclampsia) along with a strong NPV (90.8% for hypertensive disorders of pregnancy, 97.3% for gestational hypertension, 93.3% for preeclampsia), making it an effective screening tool for ruling out hypertensive disorders of pregnancy. These findings are consistent with the results reported by consistent Khanijo et al.¹⁴ Clinically, a high negative predictive is particularly valuable in antenatal care, as it helps reassure low- risk women and reduces unnecessary interventions in resource-limited settings.

Conversely, the uterine artery PI demonstrated more balanced sensitivity and specificity profile (77.1% and 83.7% for hypertensive disorders of pregnancy, 91.3% and 73.5% for gestational hypertension, 63.6% and 67.8% for preeclampsia) along with slightly higher diagnostic accuracy for overall hypertensive disorders of pregnancy (81.4%) and gestational hypertension (76.4%). This suggests that while the gestosis score may be more suitable as a screening tool, the uterine artery PI may offer greater reliability in confirming risk and improving overall diagnostic precision. Its predictive value appears to be strongest when combined with clinical parameters or when assessed in later stages of pregnancy, as highlighted by O’Gorman et al and Lee et al.^{16,17}

Recent international evidence supports the use of first-trimester multimodal screening for hypertensive disorders of pregnancy rather than reliance on a single clinical or biophysical marker. The widely validated Fetal Medicine Foundation (FMF) competing-risks model combines maternal characteristics, mean arterial pressure, uterine artery PI and biochemical markers such as placental growth factor and consistently demonstrates superior predictive performance for preterm preeclampsia compared with any individual parameter alone. External validation studies have shown that the FMF model has been successfully applied across diverse populations, although its performance varies according to population characteristics and availability of biomarkers.^{18,19}

Strengths and limitations

The study's strength lies in its comprehensive comparison of gestosis score and uterine artery PI across different hypertensive disorders of pregnancy subtypes, supported by ROC analysis. However, the relatively small sample size (n=140) limits generalizability. The low incidence of severe PE (2.1%) reduced the statistical power for this subgroup, and the single-centre design may not adequately reflect regional variations in hypertensive disorder of pregnancy risk.

CONCLUSION

This study highlights the complementary strengths of the gestosis score and uterine artery PI as predictive tools for hypertensive disorders of pregnancy. The gestosis score, with its higher sensitivity and AUC (0.855), is particularly effective for early screening and ruling out hypertensive disorders of pregnancy. It is especially valuable in resource-limited settings as it relies on clinical assessment rather than advanced technology. Conversely, uterine artery PI offers balanced sensitivity and specificity, with superior diagnostic accuracy for hypertensive disorders of pregnancy and gestational, and a notably high AUC (0.889) for preeclampsia, underscoring its utility as a non-invasive Doppler-based marker. Gestosis score exhibited superior prediction for severe preeclampsia in comparison to uterine artery pulsatility index. However, the findings indicate that combining these tools may improve the prediction of hypertensive disorders of pregnancy, facilitating earlier interventions to reduce maternal and fetal complications, including preterm delivery and low birth weight. Further research should aim to refine the threshold values of these tools and investigate their combined use to enhance and standardize screening strategies worldwide.

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