



ORIGINAL ARTICLE

**Placental Laterality as a Predictor of Pre-Eclampsia: A Prospective Comparative Study From a Tertiary Care Centre in South India**

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**Abstract**

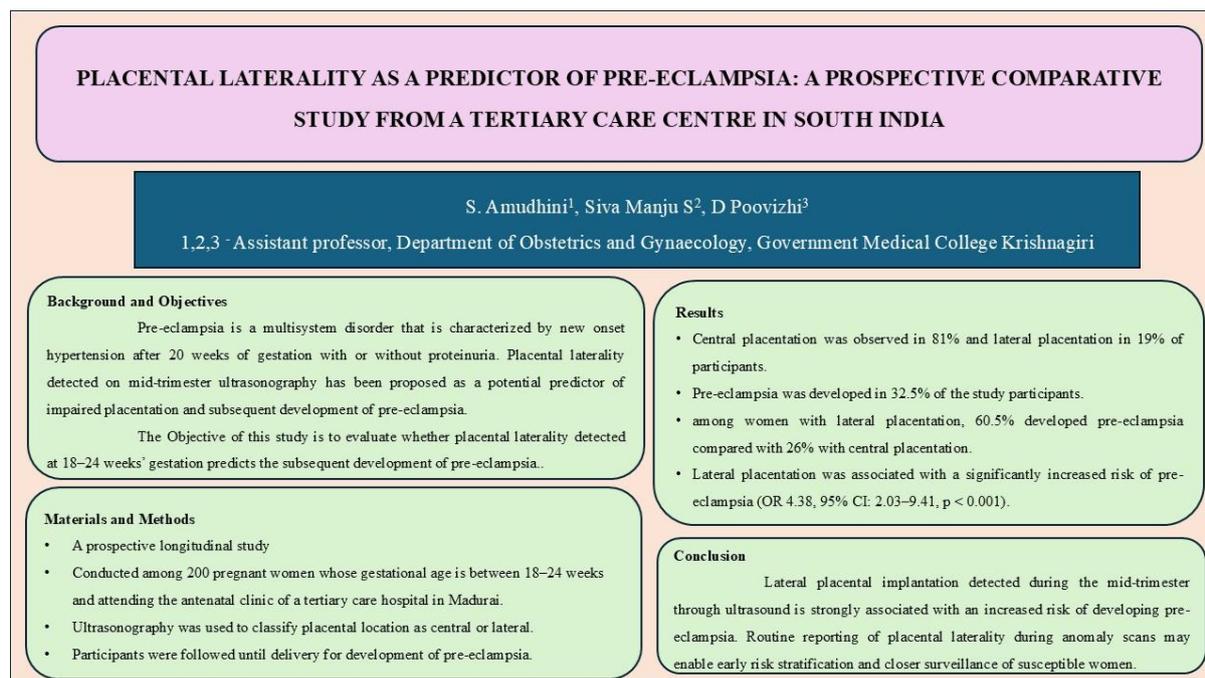
**Background:** Pre-eclampsia, a multisystem disorder marked by new-onset hypertension after 20 weeks, affects 2–8% of pregnancies and remains a major cause of maternal mortality in low- and middle-income countries. Mid-trimester placental laterality on ultrasound is suggested as a predictor of impaired placentation and future pre-eclampsia. Simple, low-cost predictive tools are crucial for early detection, especially in resource-limited settings. **Aims and objectives:** To evaluate whether placental laterality detected at 18–24 weeks' gestation predicts the subsequent development of pre-eclampsia. **Materials and Methods:** A prospective longitudinal study was conducted among 200 pregnant women whose gestational age is between 18–24 weeks and attending the antenatal clinic of a tertiary care hospital in Madurai. Women presented with pre-existing medical or obstetric comorbidities were excluded. Ultrasonography was used to classify placental location as central or lateral. Participants were followed until delivery for development of pre-eclampsia. Collected data were compiled using MS Excel software, and statistical analysis included Chi-square test, independent t-test, sensitivity–specificity indices, and odds ratios with 95% CI. **Results:** In our study the central placentation was observed in 81% and lateral placentation in 19% of participants. Pre-eclampsia was developed in 32.5% of the study participants. It was also reported that among women with lateral placentation, 60.5% developed pre-eclampsia compared with 26% with central placentation. Lateral placentation was associated with a significantly increased risk of pre-eclampsia (OR 4.38, 95% CI: 2.03–9.41,  $p < 0.001$ ). Blood pressure measurements demonstrated a significant rise in both systolic and diastolic pressures for the lateral placenta group by the fourth visit ( $p = 0.001$ ). **Conclusion:** Lateral placental implantation detected during the mid-trimester through ultrasound is strongly associated with an increased risk of developing pre-eclampsia. Routine reporting of placental laterality during anomaly scans may enable early risk stratification and closer surveillance of susceptible women.

**Keywords:** Pre-eclampsia, Placental laterality, Mid-trimester ultrasound, Hypertensive disorders, Predictive factors

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## Graphical Abstract



### Introduction

Hypertensive disorders of pregnancy (HDP) were among the most common and significant medical complications that occurs during pregnancy globally and it significantly contributes to the maternal and perinatal morbidity and mortality. Pre-eclampsia is a multisystem disorder that can be characterised by new-onset hypertension after 20 weeks of gestation with or without proteinuria, affects approximately 2–8% of pregnancies globally. It is also the leading direct cause of maternal mortality in low- and middle-income countries [1,2]. In India, pre-eclampsia and eclampsia together account for nearly 5–7% of maternal deaths, underscoring the need for early prediction and prevention strategies [3].

The clinical manifestations usually appear in the second trimester of pregnancy but the pathogenesis of pre-eclampsia begins even before that. Impaired trophoblastic invasion, defective remodelling of spiral arteries, and resultant

high-resistance uteroplacental blood flow are central pathophysiological events that is associated with pre-eclampsia [4,5]. These abnormalities may lead to experience placental hypoxia, oxidative stress, release of anti-angiogenic factors, and widespread maternal endothelial dysfunction, which combined together can produce the clinical syndrome of pre-eclampsia [4].

Identifying this condition at an early stage with reliable, and cost-effective predictors for pre-eclampsia is considered as a public health priority. Placental laterality is recognised as a predictor and it can be assessed on mid-trimester ultrasonography. A centrally located placenta generally receives balanced perfusion from both uterine arteries, whereas a laterally implanted placenta depends predominantly on one uterine artery, resulting in asymmetrical blood supply and higher uterine artery resistance [6]. This hemodynamic discrepancy may predispose to impaired placentation and subsequent development of pre-eclampsia.

Many research articles have reported that laterally located placentas are significantly associated with a higher incidence of pre-eclampsia and intrauterine growth restriction (IUGR) [6-9]. A meta-analysis by Naik et al. demonstrated nearly a 3.5-fold increased risk of pre-eclampsia among women with lateral placentation on second-trimester ultrasound [9]. Given that anomaly scans are universally performed between 18–24 weeks even in resource-limited settings, placental laterality offers an inexpensive, non-invasive adjunctive screening tool.

The present study, conducted at a tertiary care centre in South India, evaluates whether placental laterality detected during the second trimester can predict the development of pre-eclampsia, thereby aiding early risk stratification and targeted surveillance.

### **Aim and Objective**

To find whether placental laterality as determined by ultrasound done between 18–24 weeks can be used as a predictor for the development of pre-eclampsia.

### **Methodology**

#### ***Study design and setting***

This was a prospective comparative study conducted in the Department of Obstetrics and Gynaecology, Government Rajaji Hospital and Madurai Medical College, Madurai, Tamil Nadu. The study was carried out over a period of one year among pregnant women attending the antenatal clinic both as outpatient and inpatient at the hospital.

#### ***Study population***

The study population comprised pregnant women between 18 and 24 weeks of gestation with singleton pregnancies

attending the antenatal clinic during the study period.

#### ***Inclusion criteria***

- Pregnant women at 18–24 weeks of gestation
- Singleton pregnancy
- No identifiable high-risk factors at recruitment

#### ***Exclusion criteria***

- Chronic/essential hypertension
- Diabetes mellitus
- Thyrotoxicosis
- Renal disease
- Severe anaemia
- Connective tissue disorders or positive lupus anticoagulant/anticardiolipin antibodies
- Rh incompatibility
- Multiple gestation
- Positive VDRL test

#### ***Sample size and sampling***

The minimum required sample size was calculated as 198, based on the reported prevalence of pregnancy-induced hypertension among women with lateral placentation of 48.5% [10], using the standard formula  $n = Z^2pq/d^2$  with 95% confidence level ( $\alpha = 0.05$ ) and 7% absolute precision. The sample size was rounded off to 200 participants. A simple random sampling method was used to recruit eligible women.

#### ***Assessment of placental location***

All eligible women underwent an ultrasonographic examination between 18 and 24 weeks of gestation to determine placental location. Placental position was classified as:

- Central placenta – placental tissue approximately equally distributed on

both right and left sides of the uterine midline, irrespective of anterior, posterior or fundal attachment.

- Lateral placenta –  $\geq 75\%$  of the placental mass situated on one side of the uterine midline [9].

Based on this, women were grouped into:

- Central placentation group (non-exposed)
- Lateral placentation group (exposed)

#### *Assessment of the Primary Outcome*

All enrolled women were followed throughout pregnancy for the development

of signs and symptoms of pre-eclampsia at each antenatal visit. Pre-Eclampsia was defined and categorised as per the diagnostic criteria of ACOG Practice bulletin [11].

#### **Results**

A total of 200 pregnant women between 18 and 24 weeks of gestation were enrolled. Based on mid-trimester ultrasonography, 162 women (81%) had centrally located placenta and 38 women (19%) had laterally located placenta as shown in Table 1.

Table 1. Distribution of participants by placental location

<b>Placenta</b>	<b>Frequency (N)</b>	<b>Percentage (%)</b>
<b>Lateral</b>	38	19.0
<b>Central</b>	162	81.0
<b>Total</b>	200	100

Participants were grouped based on their placental position, and both the groups were similar with respect to the baseline variables like Age, Parity and family history of hypertension ( $p < 0.05$ ).

Among the 200 pregnant women studied, 59 (29.5%) developed pre-eclampsia, 4 (2%) had severe pre-eclampsia, and 2 (1%) progressed to eclampsia, as shown in Table 2. Among women with lateral placentation ( $n=38$ ), 18 (47.4%) developed pre-eclampsia, 3 (7.9%)

developed severe pre-eclampsia, and 2 (5.3%) developed eclampsia. In contrast, among those with central placentation ( $n=162$ ), the majority were normotensive, with lower proportions of pre-eclampsia (24.7%), severe pre-eclampsia (0.6%), and no cases of eclampsia. These findings indicate that lateral placentation is associated with a substantially higher risk and greater severity of hypertensive disorders of pregnancy compared to central placentation as shown in Table 3 and 4.

Table 2. Distribution of study participants based on development of hypertension

<b>Pregnancy induced hypertension (PIH)</b>	<b>Frequency (N)</b>	<b>Percentage (%)</b>
<b>Yes</b>	65	32.5
<b>No</b>	135	67.5
<b>Total</b>	200	100

Table 3. Distribution of study participants based on severity of Pre-eclampsia

<b>Pre-Eclampsia</b>	<b>Frequency (N)</b>	<b>Percentage (%)</b>
<b>Pre-Eclampsia</b>	59	29.5
<b>Severe – Pre Eclampsia</b>	4	2.0
<b>Eclampsia</b>	2	1.0
<b>Nil</b>	135	67.5
<b>Total</b>	200	100

Table 4. Placental Location across the categories of Pre-Eclampsia

<b>Placenta</b>	<b>Pre- Eclampsia</b>	<b>Severe Pre-Eclampsia</b>	<b>Eclampsia</b>	<b>Total</b>
<b>Lateral</b>	18	3	2	38
<b>Central</b>	40	1	0	162
<b>Total</b>	59	4	2	200

A strong association was observed between placental laterality and the development of pre-eclampsia. Among those with lateral placentation, 23 out of 38 women (60.5%) developed pre-eclampsia, whereas among those with central placentation, only 42 out of 162 women

(26%) developed pre-eclampsia. This association was statistically significant ( $p = 0.0001$ ). The calculated odds ratio was 4.38, indicating that women with lateral placentation were 4.38 times more likely to develop pre-eclampsia than those with central placentation as shown in Table 5.

Table 5. Comparison of Placental Location and the development of Pre-Eclampsia

Placenta	Pre-Eclampsia		OR (95% CI)	P-value
	Yes (n)	No (n)		
Lateral	23	15	4.3810	0.0001
Central	42	120		

Blood pressure trends further supported this association. By the fourth follow-up visit, women with lateral placentation showed a significantly higher mean systolic blood pressure ( $132.1 \pm 18.8$  mmHg) compared to those with central placentation ( $120.7 \pm 14.2$  mmHg) ( $p =$

0.001). Similarly, the mean diastolic blood pressure was significantly higher in the lateral placenta group ( $87.4 \pm 12.9$  mmHg) compared to the central placenta group ( $79.4 \pm 10.2$  mmHg) ( $p = 0.001$ ) as shown in Table 6.

Table 6. Blood pressure values during follow-up visits

Visit	Placental Location	Mean Systolic BP (mmHg)	p-value (Systolic)	Mean Diastolic BP (mmHg)	p-value (Diastolic)
2nd Trimester (1st visit)	Lateral	$117.6 \pm 4.3$	0.630	$77.9 \pm 4.7$	0.364
	Central	$118.1 \pm 4.6$		$77.0 \pm 5.3$	
2nd Visit	Lateral	$117.6 \pm 7.1$	0.406	$75.3 \pm 6.5$	0.367

	<b>Central</b>	116.8 ± 5.2		76.2 ± 5.3	
<b>3rd Visit</b>	<b>Lateral</b>	118.2 ± 10.9	0.037	77.1 ± 6.9	0.141
	<b>Central</b>	115.2 ± 7.0		75.2 ± 7.0	
<b>4th Visit</b>	<b>Lateral</b>	132.1 ± 18.8	0.001	87.4 ± 12.9	0.001
	<b>Central</b>	120.7 ± 14.2		79.4 ± 10.2	

### Discussion

In our prospective comparative study that was conducted among 200 pregnant women between 18 and 24 weeks of gestation, a significant association was observed between placental laterality and the subsequent development of pre-eclampsia. Lateral placentation was identified in 19% of the study population, while 81% exhibited central implantation. Among women with lateral placenta, 60.5% developed pre-eclampsia, compared with 26% among those with central placentation, reflecting an odds ratio of 4.38, demonstrating that women with lateral placenta have four times more chances to develop pre-eclampsia compared to central placentation group. These findings strongly indicate that placental laterality, as detected on routine mid-trimester ultrasonography, can serve as an efficient and low-cost early predictor for the disorder.

The results corroborate earlier reports describing the relationship between abnormal placentation and hypertensive disorders of pregnancy. Yousuf et al. showed that lateral placenta, when combined with abnormal uterine artery Doppler indices, significantly increased the likelihood of pregnancy-induced

hypertension, with more than half of lateral placenta cases progressing to pre-eclampsia [6]. Dagklis et al. similarly demonstrated that lateral placentation was associated with elevated uterine artery resistance indices and a higher incidence of pre-eclampsia and fetal growth restriction [7]. Faizi et al. also reported that laterally located placentas had increased rates of pre-eclampsia compared to centrally placed placentas [8]. Moreover, the meta-analysis by Naik et al., reviewing 16 studies, confirmed a consistent association, estimating a 3.48-fold increase in risk of pre-eclampsia among women with lateral placentation [9]. The magnitude of risk in the present study (OR 4.38) is congruent with these previously published findings.

A centrally implanted placenta typically receives balanced perfusion from both uterine arteries, whereas a placenta situated laterally is predominantly supplied by a single uterine artery. This asymmetric blood flow results in increased placental vascular resistance, greater susceptibility to ischemia, and shallower trophoblast invasion factors collectively central to the development of the hypertensive phenotype of pre-eclampsia [5,6,12].

Our study further demonstrated that blood pressure patterns across gestation reflected this impaired placentation. While systolic and diastolic pressures in both groups were similar during mid-pregnancy, significant differences emerged later, with women in the lateral placenta group showing markedly higher blood pressure levels at the fourth visit (mean systolic 132.1 mmHg vs. 120.7 mmHg; mean diastolic 87.4 mmHg vs. 79.4 mmHg;  $p = 0.001$  for both). This late-pregnancy escalation is consistent with the classical temporal progression of pre-eclampsia described in pathophysiological and clinical studies [2,4,11].

Overall, the findings of this study reinforce the growing evidence that placental laterality is an important and clinically meaningful predictor of pre-eclampsia. As a simple and widely accessible tool, placental location assessment should be considered an essential component of mid-trimester ultrasonography, especially in settings where advanced predictive modalities such as biochemical markers or uterine artery Doppler assessment are not routinely available.

## Conclusion

This prospective study reports that placental laterality identified on mid-trimester ultrasonography is a significant predictor of pre-eclampsia. Women with lateral placentation had more than a fourfold increased risk of developing pre-eclampsia compared with those with centrally located placenta, and they exhibited a greater rise in both systolic and diastolic blood pressure as pregnancy advanced. These findings correlated with the physiological association between

asymmetric uteroplacental perfusion and impaired placentation.

## Author Contributions

SA contributed to the conceptualization and definition of the intellectual content of the manuscript. SM was responsible for the design of the study, data analysis, and statistical analysis, and contributed to the definition of intellectual content. DP and played a key role in literature search, data acquisition, manuscript editing, and manuscript review. SM will serve as the corresponding author /guarantor of the manuscript

## Data availability statement

Access to the study data can be provided by the corresponding author upon request. Public sharing is restricted to protect participant confidentiality, as the dataset includes potentially identifiable information.

## Statements and Declarations

### Conflicts of interest

The authors declare that they do not have conflict of interest.

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