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Original Research Article

ASSOCIATION OF PLACENTAL LOCATION AT MID-TRIMESTER WITH MATERNAL AND FETAL OUTCOMES: A PROSPECTIVE STUDY

Anisa Begum[1], Kalpana G.[2], Ambika Premarajan[3]

[1]*Assistant Professor, Department of OBG, Government medical college Jayshankar Bhupalpally, Kompalle, Telangana, India.*
[2]*Associate Professor, Department of OBG, P.K. Das Institute of Medical sciences, Vaniamkulam, Ottapalam, Palakkad, Kerala, India.*
[3]*Assistant Professor, Department of OBG, Malabar Medical College, Ulliyeri, Modakkallur, Kozhikode, Kerala, India.*

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Corresponding Author:
Dr. Anisa Begum,
Assistant Professor, Department of OBG, Government medical college Jayshankar Bhupalpally, Kompalle, Telangana, India..
Email: anissa.m.258@gmail.com

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ABSTRACT

Background: Placental location is a crucial determinant of uteroplacental perfusion and has been associated with adverse pregnancy outcomes. However, Indian data, particularly from southern regions, remain limited. Aim: To assess the association of placental location at mid-trimester with maternal and fetal outcomes in singleton pregnancies.

Materials and Methods: A prospective observational study was conducted. A total of 474 pregnant women with singleton gestations between 18-24 weeks were enrolled. Placental site was categorized as anterior (n=216), posterior (n=191), or lateral (n=67) by ultrasound. Maternal outcomes assessed included gestational hypertension, preeclampsia, gestational diabetes mellitus, preterm labour, and abruptio placenta. Fetal outcomes included intrauterine growth restriction (IUGR), birth weight, and mode of delivery. Data were analyzed using ANOVA and Chi-square tests, with 95% confidence intervals and $p<0.05$ considered significant.

Results: Lateral placentation was associated with significantly earlier gestational age at delivery (37.15 ± 1.95 weeks vs anterior 38.05 ± 1.90; p=0.00094). Maternal complications were more frequent with lateral placentas: preterm labour 26.9% (p<0.001), gestational hypertension 25.4% (p<0.0001), and preeclampsia 11.9% (p=0.0047). IUGR was highest in the lateral group (19.4% vs anterior 7.9%; p=0.025), with lower mean birth weight (2.72 ± 0.44 kg vs anterior 2.96 ± 0.41 kg; p=0.00026). Cesarean section rates were significantly higher in the lateral group (52.2% vs anterior 31.0%; p=0.0018).

Conclusion: Placental location at mid-trimester, especially lateral implantation, is a useful predictor of adverse maternal and fetal outcomes. Incorporating placental site assessment in routine anomaly scans may help stratify high-risk pregnancies and guide targeted antenatal surveillance.

Keywords: Placental location, Maternal outcomes, Fetal outcomes.

INTRODUCTION

The placenta is a vital, transient organ that serves as the lifeline between the mother and fetus throughout pregnancy. It is responsible for a wide array of critical functions including nutrient transfer, waste elimination, gas exchange, endocrine activity, and immunological protection. Its unique anatomical and physiological design allows the fetus to develop in an intrauterine environment shielded from maternal immune rejection while simultaneously receiving adequate nourishment for optimal growth. Structurally, the placenta comprises fetal components derived from the chorionic frondosum and maternal components derived from the decidua basalis, merging into an intricate interface that ensures successful gestation.[1]

Placental location, assessed primarily through obstetric ultrasonography, has emerged as a clinically important factor in maternal-fetal medicine. Historically, assessment of placental implantation was attempted through invasive or less accurate methods such as manual exploration, isotopic placentography, or soft tissue radiography. With the

advent of ultrasonography, non-invasive, accurate, and repeatable localization of the placenta became possible, making it a cornerstone of antenatal care. Today, placental location determined at the mid-trimester anomaly scan (18-24 weeks) has been shown to correlate with a range of maternal and fetal outcomes, including preeclampsia, preterm labor, intrauterine growth restriction (IUGR), and mode of delivery.[2]

The site of placental implantation within the uterine cavity is not random; it reflects early embryonic development and influences uteroplacental blood flow. Normally, central or fundal placement allows balanced perfusion from both uterine arteries. However, lateral implantation may be associated with asymmetrical perfusion, leading to higher vascular resistance and predisposition to disorders of uteroplacental insufficiency. Multiple studies across the globe have highlighted associations between laterally located placenta and hypertensive disorders of pregnancy, particularly preeclampsia.[3]

Maternal complications such as gestational hypertension, preeclampsia, and abruptio placenta have been studied in relation to placental site. Hypertensive disorders affect 5-10% of pregnancies worldwide and are major contributors to maternal morbidity and mortality. Placental malperfusion due to shallow trophoblastic invasion of spiral arterioles is a well-established etiological mechanism for preeclampsia. Lateral placentation has been particularly associated with poor trophoblastic invasion, thereby increasing the likelihood of developing hypertensive disorders. Abruptio placenta, a condition defined as premature separation of the placenta from the uterine wall, has also been linked to abnormal placentation. Defective remodeling of the spiral arteries and local inflammation contribute to its pathogenesis. Certain placental sites may predispose to abruption due to vascular vulnerability and impaired anchorage.[4]

For the fetus, placental location influences growth trajectories and neonatal outcomes. IUGR, defined as birth weight below the 10th percentile for gestational age, is a major complication of uteroplacental insufficiency. Multiple studies indicate that laterally located placenta predisposes the fetus to restricted growth, stillbirth, and higher rates of neonatal intensive care admissions. In addition, posterior placental locations have been reported to increase risks of preterm labor and low birth weight, possibly due to reduced efficiency in maternal-fetal nutrient transfer.[5]

Aim

To assess the association of placental location at mid-trimester (18-24 weeks) with maternal and fetal outcomes in singleton pregnancies.

Objectives

1. To determine whether placental location at mid-trimester is associated with maternal complications such as preeclampsia, gestational hypertension, gestational diabetes, preterm labor, and abruptio placenta.
2. To evaluate the relationship between placental location and fetal outcomes including intrauterine growth restriction, birth weight, and mode of delivery.
3. To compare the incidence of adverse pregnancy outcomes across anterior, posterior, and lateral placental sites.

MATERIALS AND METHODS

Source of Data: The study was conducted prospectively on pregnant women attending the antenatal outpatient clinics and admitted in hospital.

Sample Size: A total of 474 pregnant women were included in the study. Sample size was calculated using effect size from previous studies (Yousuf et al. (2016)[6], ensuring adequate power to detect significant associations across placental location groups.

Inclusion Criteria

- Pregnant women aged 18-35 years.
- Singleton pregnancies between 18-24 weeks of gestation.
- Willing to provide informed consent.

Exclusion Criteria

- Multiple gestations.
- Placenta previa detected on ultrasonography.
- Pregnant women with pre-existing medical conditions (e.g., chronic hypertension, pre-gestational diabetes, cardiac disease, chronic renal disease, connective tissue disorders).
- Fetuses with congenital anomalies detected on mid-trimester ultrasound.

Procedure and Methodology: All enrolled women underwent routine mid-trimester ultrasonography between 18 and 24 weeks. Placental location was determined using a ultrasound scanner with a 3.5 MHz convex probe. The placenta was identified as a hyperechoic structure distinct from the amniotic fluid and fetus. Placental sites were classified as:

- **Anterior**: covering anterior uterine wall and extending to fundus.
- **Posterior**: covering posterior uterine wall and extending to fundus.
- **Lateral**: more than two-thirds of placental width deviated to right or left side of midsagittal uterine line.

Participants were followed until delivery. Maternal monitoring included regular blood pressure measurement, glucose tolerance testing (DIPSI criteria: 75g glucose, 2h plasma glucose ≥140 mg/dl), urine analysis for proteinuria, and clinical surveillance for complications. Outcomes assessed included:

- Preterm labor (<37 weeks).
- Gestational hypertension (≥140/90 mmHg after 20 weeks without proteinuria).
- Preeclampsia (≥140/90 mmHg with proteinuria after 20 weeks).

- Abruptio placenta (clinically/sonographically confirmed).
- Gestational diabetes mellitus.
- Intrauterine growth restriction (fetal weight <10th percentile for gestational age).
- Mode of delivery and neonatal outcome.

Sample Processing

Routine laboratory investigations were performed for all participants, including hemoglobin, urine analysis, blood grouping, and oral glucose tolerance test. Ultrasound data were recorded systematically, and women were followed up until delivery to document outcomes.

Data Collection

- A structured proforma was used to capture demographic details, obstetric history, clinical findings, and laboratory results.
- Written informed consent was obtained from all participants.
- Confidentiality and ethical standards were maintained throughout.

Statistical Methods: Data were entered and analyzed using SPSS version 18. Continuous variables (e.g., maternal age, gestational age at delivery, birth weight) were expressed as mean ± standard deviation and compared across placental location groups using ANOVA with post-hoc Tukey's test. Categorical variables (e.g., preeclampsia, preterm labor, IUGR, gestational diabetes) were expressed as frequencies and percentages and compared using the Chi-square test. A p-value of <0.05 was considered statistically significant.

RESULTS

Among the 474 women studied, placental location was anterior in 216 cases (45.6%), posterior in 191 cases (40.3%), and lateral in 67 cases (14.1%). The mean maternal age was comparable across groups (25.3 ± 4.4 years in anterior, 24.8 ± 4.3 years in posterior, and 25.6 ± 4.5 years in lateral groups), with no statistically significant difference (ANOVA $F(2,471) = 1.09$, $p = 0.336$). The mean gestational age at delivery differed significantly, being lowest in the lateral group (37.15 ± 1.95 weeks) compared with the anterior (38.05 ± 1.90 weeks) and posterior (38.10 ± 1.80 weeks) groups (ANOVA $F(2,471) = 7.07$, $p = 0.00094$; mean difference lateral-anterior = −0.90 weeks, 95% CI −1.43 to −0.37). Mean OGTT values were similar across groups (anterior 122.0 ± 27.5 mg/dL, posterior 121.0 ± 23.5 mg/dL, lateral 118.0 ± 26.5 mg/dL), with no significant association (ANOVA $F(2,471) = 0.61$, $p = 0.542$).

Table 1: Baseline profile & key antenatal parameters by placental location (N=474)

Variable	Anterior (n=216)	Posterior (n=191)	Lateral (n=67)	Overall test (df)	p-value	Key pairwise effect (95% CI)
Placental location, n (%)	216 (45.6)	191 (40.3)	67 (14.1)	-	-	-
Maternal age (years), Mean ± SD	25.3 ± 4.4	24.8 ± 4.3	25.6 ± 4.5	ANOVA F(2,471)=1.09	0.336	L-A mean diff = 0.30 (−0.93, 1.53)
GA at delivery (weeks), Mean ± SD	38.05 ± 1.90	38.10 ± 1.80	37.15 ± 1.95	ANOVA F(2,471)=7.07	0.00094	L-A mean diff = −0.90 (−1.43, −0.37)
2-h OGTT (mg/dL), Mean ± SD	122.0 ± 27.5	121.0 ± 23.5	118.0 ± 26.5	ANOVA F(2,471)=0.61	0.542	L-A mean diff = −4.0 (−11.33, 3.33)

Table 2: Maternal complications by placental location (N=474)

Outcome	Anterior n (%)	Posterior n (%)	Lateral n (%)	Overall χ^2 (df=2)	p-value	Risk difference (L-A) [95% CI]
Preterm labour (<37 w)	16 (7.4)	21 (11.0)	18 (26.9)	18.99	<0.001	+0.195 [0.083, 0.306]
Gestational hypertension	3 (1.4)	13 (6.8)	17 (25.4)	45.43	<0.0001	+0.240 [0.134, 0.345]
Preeclampsia	5 (2.3)	9 (4.7)	8 (11.9)	10.71	0.0047	+0.096 [0.016, 0.176]
GDM	52 (24.1)	34 (17.8)	9 (13.4)	4.62	0.099	−0.106 [−0.206, −0.0068]
Abruptio placenta	1 (0.5)	3 (1.6)	3 (4.5)	5.68	0.058	+0.040 [−0.010, 0.090]

Placental location showed clear associations with maternal complications. Preterm labour occurred in 26.9% of women with lateral placentation, compared with 7.4% in anterior and 11.0% in posterior sites ($\chi^2 = 18.99$, $p < 0.001$; risk difference lateral-anterior = +0.195, 95% CI 0.083-0.306). Gestational hypertension was also more frequent with lateral placentation (25.4%) versus posterior (6.8%) and anterior (1.4%) ($\chi^2 = 45.43$, $p < 0.0001$; risk difference = +0.240, 95% CI 0.134-0.345). Similarly, preeclampsia was more common in the lateral group (11.9%) compared with anterior (2.3%) and posterior (4.7%) ($\chi^2 = 10.71$, $p = 0.0047$). Although gestational diabetes mellitus (GDM) was most frequent in the anterior group (24.1%), the overall difference across sites was not statistically significant ($p = 0.099$). Abruptio placenta was uncommon overall but appeared more frequent in the lateral group (4.5%) compared to anterior (0.5%) and posterior (1.6%), showing a near-significant trend ($p = 0.058$).

Table 3: Fetal outcomes and mode of delivery by placental location (N=474)

Outcome	Anterior n/Mean (SD)	Posterior n/Mean (SD)	Lateral n/Mean (SD)	Test (df)	p-value	Pairwise effect with 95% CI
IUGR, n (%)	17 (7.9)	19 (9.9)	13 (19.4)	$\chi^2(2)=7.39$	0.0248	RD (L-A)= +0.115 [0.014, 0.217]
Birth weight (kg), Mean ± SD	2.96 ± 0.41	2.90 ± 0.42	2.72 ± 0.44	ANOVA F(2,471)=8.42	0.00026	Mean diff (L-A)= −0.24 kg [−0.359, −0.121]
Mode of delivery						
Normal vaginal delivery, n (%)	147 (68.1)	129 (67.5)	31 (46.3)			
Cesarean (LSCS), n (%)	67 (31.0)	56 (29.3)	35 (52.2)	$\chi^2(2)=12.68$ (LSCS yes/no)	0.00176	RD (LSCS L-A)= +0.212 [0.078, 0.347]
Instrumental vaginal, n (%)	1 (0.5)	6 (3.1)	1 (1.5)			
Hysterotomy, n (%)	1 (0.5)	0 (0.0)	0 (0.0)	MOD distribution $\chi^2(6)=18.10$	0.0060	-

Intrauterine growth restriction (IUGR) was significantly more frequent in the lateral placental group (19.4%) compared to anterior (7.9%) and posterior (9.9%) (χ^2 = 7.39, p = 0.0248; risk difference lateral-anterior = +0.115, 95% CI 0.014-0.217). Mean birth weight was lowest in the lateral group (2.72 ± 0.44 kg) compared to anterior (2.96 ± 0.41 kg) and posterior (2.90 ± 0.42 kg), and this difference was statistically significant (ANOVA F(2,471) = 8.42, p = 0.00026; mean difference lateral-anterior = −0.24 kg, 95% CI −0.359 to −0.121). With respect to mode of delivery, normal vaginal delivery predominated in the anterior (68.1%) and posterior (67.5%) groups, while cesarean section was significantly higher in the lateral group (52.2%) (χ^2 = 12.68, p = 0.00176; risk difference = +0.212, 95% CI 0.078-0.347). Instrumental deliveries were uncommon (≤3.1%), and only one case of hysterotomy was reported in the anterior group. These results suggest that lateral placental location is associated with higher risks of IUGR, lower birth weight, and increased cesarean delivery.

Table 4: Summary comparison of adverse pregnancy outcomes across placental sites (incidence % and heterogeneity)

Adverse outcome	Anterior %	Posterior %	Lateral %	χ^2 (df=2)	p-value	RD (L-A) [95% CI]
Preterm labour	7.4	11.0	26.9	18.99	<0.001	+0.195 [0.083, 0.306]
Gestational hypertension	1.4	6.8	25.4	45.43	<0.0001	+0.240 [0.134, 0.345]
Preeclampsia	2.3	4.7	11.9	10.71	0.0047	+0.096 [0.016, 0.176]
IUGR	7.9	9.9	19.4	7.39	0.0248	+0.115 [0.014, 0.217]
Abruptio placenta	0.5	1.6	4.5	5.68	0.058	+0.040 [−0.010, 0.090]
Cesarean (LSCS)	31.0	29.3	52.2	12.68	0.00176	+0.212 [0.078, 0.347]

A summary comparison across placental sites further emphasizes the adverse outcomes associated with lateral placentation. Preterm labour was markedly higher in the lateral group (26.9%) compared to anterior (7.4%) and posterior (11.0%) (χ^2 = 18.99, p < 0.001). Gestational hypertension (25.4% vs 1.4% anterior, 6.8% posterior; χ^2 = 45.43, p < 0.0001) and preeclampsia (11.9% vs 2.3% anterior, 4.7% posterior; χ^2 = 10.71, p = 0.0047) were also significantly more frequent in the lateral group. IUGR (19.4%) was notably higher in lateral placentation compared to anterior (7.9%) and posterior (9.9%) (χ^2 = 7.39, p = 0.0248). Abruptio placenta showed a trend towards higher frequency in the lateral group (4.5%), though not statistically significant (p = 0.058). Cesarean delivery rates were significantly elevated with lateral placenta (52.2%) compared to anterior (31.0%) and posterior (29.3%) (χ^2 = 12.68, p = 0.00176).

DISCUSSION

Baseline & antenatal profile [Table 1]. Cohort's placental distribution (anterior 45.6%, posterior 40.3%, lateral 14.1%) mirrors typical obstetric series, with no age differences by site. The only baseline parameter that separates groups is gestational age at delivery, which is ≈0.9 weeks earlier with lateral placentation versus anterior (−0.90 weeks, 95% CI −1.43 to −0.37; p≈0.001). This aligns with reports that lateral (i.e., unilateral) implantation marks suboptimal uteroplacental perfusion and earlier delivery thresholds through impaired spiral-artery remodeling (pathophysiology summarized by Lutz AB et al (2021),[7] and standard texts. By contrast, glucose tolerance (2-h OGTT) did not differ-consistent with multiple cohorts in which GDM shows weak or inconsistent association with placental site; Jansen CH et al (2020),[8] is a notable exception, reporting higher metabolic complications with **anterior** placentation (see below).

Maternal complications [Table 2]. A graded risk peaking in the lateral group for preterm labour (26.9%), gestational hypertension (25.4%), and preeclampsia (11.9%), with robust heterogeneity (χ^2, all p≤0.005). This pattern closely echoes large observational datasets:

- Laterality ↔ preeclampsia. Yousuf et al.(2016)[6] showed higher preeclampsia when the placenta is lateral, especially when uterine-artery Dopplers

are abnormal; >90% of those with lateral + Doppler abnormality developed preeclampsia, versus 6% with lateral alone (risk-enrichment concept that matches Gradient across sites).[1] McLaren Jr R et al (2020),[9] (n≈1,057) also reported more preeclampsia, FGR, and preterm birth in lateral placentas. O'Quinn C et al (2020),[10] similarly found a 3.5-fold higher odds of PIH with lateral placentation.

- Posterior vs lateral. Porto L et al.(2020)[11] noted posterior placentas trending with preterm delivery, and lateral with preeclampsia/IUGR. Data show the highest preterm labour in the lateral group and an intermediate rate in posterior (11%), which still coheres with the broader idea that non-central sites (posterior or lateral) signal risk, while exact rank-ordering can vary by population and definitions.
- GDM & abruption. Near-null for GDM across sites (p=0.099) is in line with several cohorts; Granfors M et al.(2020)[12] reported higher GDM with anterior and more preeclampsia/abruption with anterior than posterior. Borderline abruption signal (p≈0.058) with higher lateral percentages sits between Jansen CH et al.(2020)[13] anterior-predominant risk and the mechanistic expectation that any suboptimal placentation increases abruption via decidual vasculopathy.

Fetal outcomes & delivery [Table 3]. IUGR is highest in the lateral group (19.4%, p=0.025), with a 0.24 kg lower mean birthweight versus anterior (95% CI −0.359 to −0.121; p≈0.0003). These findings strongly parallel:

- Unilateral/lateral ↔ IUGR. Wax IR et al (2020),[14] showed IUGR pregnancies were 4× more likely to have unilateral placentation than controls. Shainker SA et al (2021),[15] also flagged higher FGR with lateral, while Premkumar A et al (2025),[16] associated lateral with IUGR and posterior with preterm. Mechanistically, unilateral supply raises resistance in the contralateral uterine artery, reducing intervillous perfusion and impairing growth.
- Mode of delivery. LSCS rate is highest in the lateral group (52.2%; p≈0.0018). Ashwal E et al (2022),[17] reported site-dependent differences in fetal presentation dynamics across the third trimester and higher CS with certain placental sites, illustrating how malpresentation and labour dystocia pathways can be site-linked. Some cohorts note higher CS with posterior, others with lateral; Data fit the broader theme that non-central sites increase operative delivery via growth restriction, hypertensive disease, and malpresentation clusters.

Synthesis [Table 4]: Pooling across outcomes underscores a consistent risk signature for lateral placentation: higher preterm labour, gestational hypertension, preeclampsia, IUGR, and cesarean rates-with abruption trending higher. This package of associations is biologically coherent with inadequate trophoblastic invasion and impaired uterine-artery remodeling, producing placental under-perfusion and downstream clinical syndromes. Differences between series-e.g., whether posterior or lateral shows the highest preterm rate-likely reflect scan timing (18-24 w vs later), definition of "lateral/unilateral," Doppler integration, and population factors (parity, BMI, care pathways). Bigelow CA et al (2020).[18]

CONCLUSION

This prospective study of 474 singleton pregnancies demonstrated that placental location assessed at mid-trimester has significant implications for maternal and fetal outcomes. Lateral placentation was consistently associated with a higher incidence of preterm labour, gestational hypertension, preeclampsia, intrauterine growth restriction, lower birth weight, and an increased likelihood of cesarean delivery. Posterior placentation showed intermediate risks, particularly for preterm birth, while anterior placentation was generally associated with more favourable outcomes. These findings support the role of placental site assessment during routine anomaly scans as a simple, non-invasive predictor of high-risk pregnancies. Early identification of women with lateral placentation may allow closer monitoring, timely interventions, and improved maternal and neonatal outcomes.

Limitations

1. **Single-centre design:** The study was conducted in one tertiary care hospital, which may limit the generalizability of results to other populations with different demographic or healthcare settings.
2. **Sample distribution:** Although the overall sample size was robust, the lateral placentation group was relatively smaller, which may reduce statistical power for some comparisons.
3. **Potential confounders:** Factors such as maternal body mass index, socioeconomic status, and nutritional status were not uniformly adjusted for, which could have influenced both placental implantation and outcomes.
4. **Ultrasound classification:** Placental location was assessed using conventional ultrasonography without integration of uterine artery Doppler indices, which might have enhanced predictive accuracy.

Follow-up limitations: Neonatal outcomes beyond the immediate postpartum period were not assessed, thereby limiting evaluation of longer-term consequences of placental location.

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