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Evaluation and Outcome of Anterior Low-Lying Placenta in Previous Lower Segment Caesarean Section Patients from 11-14 Weeks of Gestation and Subsequent Serial Scans: A Prospective Observational Study from Eastern India

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ABSTRACT

Background: Anterior low-lying placenta in women with a prior lower segment caesarean section (LSCS) is a high-risk obstetric condition predisposing to placenta accreta spectrum (PAS) disorder, antepartum haemorrhage, and peripartum mortality. Serial ultrasonography commencing at 11–14 weeks of gestation has been proposed as an early risk-stratification tool for this patient population; however, prospective evidence from resource-limited settings in South Asia remains limited.

Methods: A prospective observational cohort study was conducted at ICARE Institute of Medical Sciences and Research and Dr. B.C. Roy Hospital, Haldia, West Bengal, India, from October 2024 to June 2025. One hundred consecutive pregnant women with a prior LSCS and anteriorly implanted low-lying placenta confirmed at first-trimester ultrasonography were enrolled. Serial transabdominal and transvaginal scans were performed using a GE Voluson P8 ultrasound machine at 11–14 weeks, 18–22 weeks (anomaly scan), and 28 weeks of gestation. The distance from the lower placental margin to the internal cervical os was measured at each scan. The primary outcome was maternal mortality; secondary outcomes included fetal mortality, perioperative blood loss, morbidly adherent placenta, and mode of delivery. Chi-square, Fisher's exact, and independent-samples t-tests were applied using SPSS v27.0; $p \leq 0.05$ was considered statistically significant.

Results: The mean maternal age was 25.90 ± 4.15 years (range 20–35 years); 99% had one prior LSCS. The mean placental distance from the internal os showed minimal change across serial scans: 3.76 ± 0.65 cm at 11–14 weeks, 3.64 ± 0.62 cm at the anomaly scan, and 3.67 ± 0.66 cm at 28 weeks, indicating markedly restricted placental migration. All 100 patients (100%) delivered by LSCS at a mean gestational age of 36.60 ± 0.80 weeks. Maternal mortality occurred in 3% (n = 3) and fetal mortality in 1% (n = 1). Universal perioperative blood loss was documented across the cohort. Statistically significant predictors of maternal mortality (Fisher's exact $p = 0.030$ for each, except history of antepartum haemorrhage, $p = 0.0006$) included: multiple prior LSCS, retroplacental haemorrhage at the first-trimester scan, placenta covering the internal cervical os at 28 weeks, morbidly adherent placenta at 28 weeks,

antepartum haemorrhage, morbidly adherent placenta confirmed at delivery, and fetal mortality. Mean placental distance at 28 weeks was significantly lower in the maternal mortality group (2.77 ± 0.64 cm) compared with survivors (3.70 ± 0.64 cm; p = 0.015).
Conclusion: Anterior low-lying placenta overlying a prior caesarean uterine scar exhibits markedly restricted migration and carries substantial risk of haemorrhagic morbidity and mortality. A smaller placental distance from the internal os at 28 weeks and retroplacental haemorrhage at the first-trimester scan are significant predictors of adverse maternal outcome. These findings support integration of targeted 11-14-week placental surveillance into routine antenatal care for all women with a prior caesarean delivery.

Keywords: *Anterior low-lying placenta; placenta accreta spectrum; lower segment caesarean section; first-trimester ultrasonography; placental migration; maternal mortality; antepartum haemorrhage*

1. INTRODUCTION

The global rise of caesarean section (CS) as the dominant operative delivery modality has generated a parallel epidemic of placentation disorders in subsequent pregnancies. Placenta accreta spectrum (PAS) disorder — encompassing placenta accreta, increta, and percreta — and placenta previa are now among the leading causes of massive obstetric haemorrhage, emergency peripartum hysterectomy, and maternal death worldwide.[1,2] Placenta previa itself complicates approximately 4–5 per 1000 pregnancies in population-based cohorts, with prior caesarean delivery identified among the principal risk factors for its occurrence.[28,29] In the United States, the incidence of PAS increased nearly tenfold over three decades, currently affecting approximately 3 per 1000 deliveries, driven primarily by the escalating caesarean section rate.[26] The resultant morbidity is severe: massive haemorrhage, disseminated intravascular coagulation (DIC), acute respiratory distress syndrome, multi-organ failure, and maternal death have all been well documented in patients with PAS arising in post-LSCS pregnancies.[3,4]

The prior lower segment caesarean section (LSCS) scar constitutes the most critical predisposing substrate. The risk of placenta accreta rises exponentially with the number of antecedent uterine surgeries: from approximately 1.9% after one prior CS to nearly 40% after two or more CS in the presence of a co-existing placenta previa.[5,6] This exponential risk escalation is mechanistically explained by progressive deficiency of the decidua basalis at the lower uterine segment scar, which permits excessive trophoblastic invasion and results in firmly adherent or invading placentation.[5,6] The same scar-mediated anchoring mechanism restricts physiological placental migration — a well-established process by which a low-lying placenta in early gestation repositions into the upper uterine segment in 85–98% of uncomplicated pregnancies by the third trimester.[7,8] In post-LSCS patients with anteriorly implanted low-lying placenta, avid implantation within the collagenous scar impedes cranial repositioning, yielding persistent placenta previa or low-lying placenta, elevated vascular invasion, and substantially augmented peripartum haemorrhagic risk.[9]

Ultrasonography remains the primary, reliable, and globally accessible modality for antenatal evaluation of placentation abnormalities. Systematic grey-scale and colour Doppler examination achieves a sensitivity of approximately 77% and a specificity of approximately 96% for placenta accreta in the second and third trimesters.[10] Second- and third-trimester ultrasonographic markers of PAS include loss of the retroplacental clear zone, intraplacental vascular lacunae (particularly Grade 2+ or higher), bladder wall interruption, and abnormal uterovesical vascularity.[11,12] Despite these advances, up

to half to two-thirds of PAS cases are undiagnosed before delivery, contributing to the high perioperative complication rates encountered when the diagnosis is made unexpectedly at the time of caesarean section.[1]

More recently, prospective evidence has established the 11–14 week first-trimester scan as a critical, and historically underutilised, window for early identification of women at highest risk for PAS. Stirnemann et al. demonstrated that transvaginal ultrasonography at 11–14 weeks could stratify post-LSCS patients by trophoblastic overlap with the uterine scar.[13] Younesi et al. further classified 17.7% of screened post-LSCS patients as high-risk based on first-trimester criteria.[14] Calì et al. showed that classical ultrasonographic signs of abnormally invasive placentation — including loss of the clear space, placental lacunae, bladder wall interruption, and uterovesical hypervascularity — were already identifiable at 11–14 weeks in the majority of high-risk patients, with an overall good diagnostic accuracy across all PAS subtypes in women with placenta previa and a prior uterine scar.[15,16] Doulaveris et al. confirmed that transvaginal ultrasonography at 11–14 weeks can identify at least three-quarters of eventual PAS cases, with scar-niche implantation of the placenta carrying a high positive predictive value for PAS.[17] The Society for Maternal-Fetal Medicine (SMFM) has accordingly published standardised consensus criteria for this early screening examination.[18]

Despite this growing body of evidence, the published literature is dominated by studies from well-resourced Western tertiary centres. Prospective data from resource-limited South Asian settings — characterised by high caesarean section rates, grand multiparity, and limited access to specialised peripartum care — are sparse. Such data are essential for formulating contextually appropriate antenatal surveillance protocols. The present study was therefore undertaken with the following objectives: (1) to characterise placental migration patterns across serial ultrasonographic examinations from 11–14 weeks through 28 weeks in post-LSCS patients with anteriorly implanted low-lying placenta; (2) to document maternal and fetal outcomes in this cohort; and (3) to identify early ultrasonographic and clinical predictors of adverse maternal outcome.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This was a prospective observational cohort study conducted in the Department of Radiodiagnosis, ICARE Institute of Medical Sciences and Research and Dr. B.C. Roy Hospital, Haldia, West Bengal, India. The study was carried out between October 2024 and June 2025 (8 months).

2.2 Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of ICARE Institute of Medical Sciences and Research. The study was conducted in accordance with the Declaration of Helsinki (revised 2013). Written informed consent was obtained from all participants prior to enrolment, with explicit documentation of the voluntary nature of participation and the right to withdraw.

2.3 Study Population

Consecutive pregnant women referred from the Department of Obstetrics and Gynaecology for obstetric ultrasonography were screened for eligibility throughout the study period.

Inclusion criteria: (i) Pregnant women with a history of at least one prior LSCS presenting for first-trimester ultrasonography between 11 and 14 completed weeks of gestation in whom an anteriorly implanted low-lying placenta was detected; (ii) caesarean scar pregnancies with anterior low implantation confirmed on transvaginal scan.

Exclusion criteria: (i) Posterior low-lying placenta in women with prior LSCS; (ii) anterior low-lying placenta in nulliparous women; (iii) anterior low-lying placenta following vaginal delivery without prior LSCS.

2.4 Sample Size Calculation

Sample size was calculated using Epi Info™ 3.5.3 software (Centers for Disease Control and Prevention, Atlanta, GA, USA). Based on a published prevalence of low-lying placenta of 8.26% in a tertiary Indian cohort, [19] the minimum required sample size was estimated as 100, using the formula $n = 4pq/L^2$, where $p = 0.0826$, $q = 1 – p = 0.9174$, and $L = 0.055$ (5.5% precision), yielding a study power of 87%. Accordingly, 100 patients were enrolled.

2.5 Imaging Methodology

All ultrasonographic examinations were performed on a GE Voluson P8 ultrasound system (GE Healthcare, Chicago, IL, USA) equipped with a curvilinear transabdominal probe and a high-frequency endocavitary transvaginal probe (TVS). Gestational age was established by the last menstrual period (LMP) and confirmed by first-trimester or early second-trimester crown-rump length (CRL) measurement. Where LMP was uncertain, gestational age was assigned from the CRL.

Three serial scans were mandated for each participant at the following time-points:

Scan 1 — 11–14 weeks: First-trimester scan (transabdominal and transvaginal). Parameters documented: placental implantation site, lower uterine segment morphology, distance from the lower placental margin to the internal cervical os (transvaginal route), additional haemorrhagic findings (retroplacental haemorrhage, subchorionic haemorrhage), and evidence of scar-niche implantation.

Scan 2 — 18–22 weeks: Anomaly scan with comprehensive fetal biometry and anatomy survey. Placental implantation site and distance from the lower placental margin to the internal cervical os were re-measured.

Scan 3 — 28 weeks: Third-trimester scan to reassess placental location and distance from the internal os; evaluation for ultrasonographic features of morbidly adherent placenta (loss of retroplacental clear zone, intraplacental lacunae, bladder wall interruption, abnormal subplacental vascularity on colour Doppler); documentation of antepartum haemorrhage. Magnetic resonance imaging (MRI) was performed selectively in cases where ultrasonographic features suggested extrauterine placental invasion. All examinations were performed or directly supervised by consultant radiologists with subspecialty experience in obstetric imaging.

2.6 Outcome Measures

Primary outcome: Maternal mortality (death occurring in the peripartum period attributable to obstetric complications).

Secondary outcomes: Fetal mortality; perioperative blood loss; mode of delivery; morbidly adherent placenta confirmed at or after delivery (histological or operative confirmation); gestational age at delivery.

2.7 Statistical Analysis

Data were entered into Microsoft Excel 2019 (Microsoft Corporation, Redmond, WA, USA) and analysed using SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA) and GraphPad Prism version 5 (GraphPad Software, San Diego, CA, USA). Categorical variables are expressed as frequency and percentage; continuous variables as mean ± standard deviation (SD) with full range (minimum–maximum) and median. The chi-square (χ^2) test was used to test associations between categorical variables and maternal mortality; Fisher's exact test was applied when any expected cell frequency was < 5. Independent-samples t-test was used to compare continuous parameters between the maternal mortality and survival groups. A two-tailed p-value ≤ 0.05 was considered statistically significant in all analyses.

3. RESULTS

3.1 Participant Characteristics

One hundred patients fulfilled the eligibility criteria and were enrolled; no participants were lost to follow-up. The mean maternal age was 25.90 ± 4.15 years (range 20–35 years). The most frequent age group was 21–25 years (44%), followed by 26–30 years (29%), 31–35 years (19%), and ≤ 20 years (8%; Table 1). Parity distribution showed P1+0 in 34%, P1+1 in 19%, P2+0 in 14%, P0+1 in 12%, P3+0 and P3+1 each in 6%,

P2+1 in 3%, and P0+3 in 2% (Table 1); 82% of patients had a parity of P1+0 or greater. Previous gravida distribution was: G2 in 46%, G3 in 37%, G4 in 11%, and G5 in 6%. The vast majority of patients (99%) had undergone one prior LSCS; a single patient (1%) had two prior LSCS. Sixty-six patients (66%) were housewives and 34 (34%) were employed outside the home.

Table 1. Baseline Demographic and Obstetric Characteristics of the Study Cohort (n = 100)

Variable	Category	n	(%)
Age (years)	≤ 20	8	8.0
	21–25	44	44.0
	26–30	29	29.0
	31–35	19	19.0
Mean ± SD	25.90 ± 4.15 years (range 20–35)		
Parity	P0+1	12	12.0
	P0+2	4	4.0
	P0+3	2	2.0
	P1+0	34	34.0
	P1+1	19	19.0
	P2+0	14	14.0
	P2+1	3	3.0
	P3+0	6	6.0
	P3+1	6	6.0
Gravida	G2	46	46.0
	G3	37	37.0
	G4	11	11.0
	G5	6	6.0
Prior LSCS	One	99	99.0
	Two	1	1.0
Occupation	Housewife	66	66.0
	Employed	34	34.0

LSCS = lower segment caesarean section; SD = standard deviation; G = gravida; parity expressed as live births + pregnancy losses (e.g., P1+0 = one live birth, no losses).

3.2 First-Trimester Ultrasonographic Findings (11–14 Weeks)

The mean gestational age at the first-trimester scan was 12.49 ± 0.79 weeks (range 11.3–13.5 weeks). At this scan, the mean distance from the lower placental margin to the internal cervical os was 3.76 ± 0.65 cm (range 2.4–4.8 cm; Table 2). In 97 patients (97%), no additional haemorrhagic findings were detected at the first-trimester scan. Retroplacental haemorrhage was identified in one patient (1%), and subchorionic haemorrhage was identified in two patients (2%).

3.3 Anomaly Scan Findings (18–22 Weeks)

The mean gestational age at the anomaly scan was 19.53 ± 0.76 weeks (range 18.0–21.0 weeks). The mean placental distance from the internal cervical os at this

examination was 3.64 ± 0.62 cm (range 2.4–4.8 cm; Table 2).

3.4 Third-Trimester Scan (28 Weeks) and Placental Migration

At 28 weeks, the placenta was low-lying (defined as the lower margin within 2 cm of the internal os but not overlying it) in 99 patients (99%). In one patient (1%), the placenta was found to be covering the internal cervical os (complete placenta previa). Morbidly adherent placenta was identified on ultrasonography in one patient (1%) at this scan. A history of antepartum haemorrhage (APH) was documented in two patients (2%). The mean placental distance from the internal os at 28 weeks was 3.67 ± 0.66 cm (range 2.4–4.8 cm; Table 2).

Critically, the mean placental distance from the internal os showed minimal change across the three serial scan visits (Table 2): 3.76 cm at 11–14 weeks, 3.64 cm at the anomaly scan, and 3.67 cm at 28 weeks, representing a net change of only −0.09 cm over approximately 14 gestational weeks. This pattern indicates markedly restricted physiological placental migration in this post-LSCS cohort.

Table 2. Serial Ultrasonographic Parameters Across Gestational Scan Visits (n = 100)

Parameter	n	Mean ± SD	Min	Max
GA at 11–14 week scan (weeks)	100	12.49 ± 0.79	11.3	13.5
Placental distance at 11–14 weeks (cm)	100	**3.76 ± 0.65**	2.4	4.8
GA at anomaly scan (weeks)	100	19.53 ± 0.76	18.0	21.0
Placental distance at anomaly scan (cm)	100	**3.64 ± 0.62**	2.4	4.8
GA at 28-week scan (weeks)	100	28.00 ± 0.00	28.0	28.0
Placental distance at 28 weeks (cm)	100	**3.67 ± 0.66**	2.4	4.8
GA at delivery (weeks)	100	36.60 ± 0.80	35.0	38.0

GA = gestational age; SD = standard deviation; cm = centimetres. Bold values indicate key placental distance measurements.

3.5 Maternal and Fetal Outcomes at Delivery

All 100 patients (100%) underwent delivery by lower segment caesarean section; vaginal delivery was not achieved in any case. The mean gestational age at delivery was 36.60 ± 0.80 weeks (range 35–38 weeks). Perioperative blood loss was documented in all 100 patients (100%), reflecting the inherent haemorrhagic risk of this condition. Maternal mortality occurred in three patients (3%) and fetal mortality in one patient (1%). Morbidly adherent placenta was confirmed operatively at delivery in one patient (1%). Complete outcome data are presented in Table 3.

Table 3. Clinical and Perinatal Outcomes at Delivery (n = 100)

Outcome Variable	n	(%)
Mode of delivery: LSCS (all patients)	100	100.0
Placental location at 28 weeks: Low-lying	99	99.0
Placental location at 28 weeks: Covering internal os	1	1.0
Morbidly adherent placenta on scan at 28 weeks	1	1.0
History of antepartum haemorrhage (APH)	2	2.0
Morbidly adherent placenta confirmed at delivery	1	1.0
Perioperative blood loss	100	100.0

Outcome Variable	n	(%)
Maternal mortality	**3**	**3.0**
Fetal mortality	**1**	**1.0**

LSCS = lower segment caesarean section; APH = antepartum haemorrhage.

3.6 Bivariate Analysis: Factors Associated with Maternal Mortality

Chi-square and Fisher's exact tests were performed to identify factors significantly associated with maternal mortality (Table 4). Because the expected cell frequency was below 5 in every 2×2 comparison involving the three-patient mortality group, Fisher's exact test — rather than the uncorrected Pearson chi-square statistic — provides the valid p-value for these associations, consistent with the pre-specified analysis plan. On Fisher's exact testing, multiple prior LSCS (p = 0.030), retroplacental haemorrhage at the first-trimester scan (p = 0.030), placenta covering the internal cervical os at 28 weeks (p = 0.030), morbidly adherent placenta at 28 weeks (p = 0.030), history of APH (p = 0.0006), morbidly adherent placenta confirmed at delivery (p = 0.030), and associated fetal mortality (p = 0.030) were all significantly associated with maternal mortality. Maternal age (p = 0.8775), parity (p = 0.6360), gravida (p = 0.6354), occupational status (Fisher's exact p = 0.266), and subchorionic haemorrhage at the first-trimester scan (Fisher's exact p = 1.000) were not significantly associated with maternal mortality.

Table 4. Bivariate Analysis of Factors Associated with Maternal Mortality (n = 100)

Variable	Survival (n = 97)	Mortality (n = 3)	p-value
Age group (years)	—	—	0.8775 (NS)
≤ 20 years	8 (8.2%)	0 (0.0%)	—
21–25 years	43 (44.3%)	1 (33.3%)	—
26–30 years	28 (28.9%)	1 (33.3%)	—
31–35 years	18 (18.6%)	1 (33.3%)	—
Parity	—	—	0.6360 (NS)
P0+1	12 (12.4%)	0 (0.0%)	—
P0+2	4 (4.1%)	0 (0.0%)	—
P0+3	2 (2.1%)	0 (0.0%)	—
P1+0	33 (34.0%)	1 (33.3%)	—
P1+1	19 (19.6%)	0 (0.0%)	—
P2+0	13 (13.4%)	1 (33.3%)	—
P2+1	3 (3.1%)	0 (0.0%)	—
P3+0	5 (5.2%)	1 (33.3%)	—
P3+1	6 (6.2%)	0 (0.0%)	—
Gravida	—	—	0.6354 (NS)
G2	45 (46.4%)	1 (33.3%)	—
G3	36 (37.1%)	1 (33.3%)	—
G4	10 (10.3%)	1 (33.3%)	—
G5	6 (6.2%)	0 (0.0%)	—

Variable	Survival (n = 97)	Mortality (n = 3)	p-value
Occupation: employed	32 (33.0%)	2 (66.7%)	0.266 (NS)
≥ 2 prior LSCS	0 (0.0%)	1 (33.3%)	**0.030 ***
Retroplacental haemorrhage at 11–14 weeks	0 (0.0%)	1 (33.3%)	**0.030 ***
Subchorionic haemorrhage at 11–14 weeks	2 (2.1%)	0 (0.0%)	NS
Placenta covering internal os at 28 weeks	0 (0.0%)	1 (33.3%)	**0.030 ***
Morbidly adherent placenta at 28 weeks	0 (0.0%)	1 (33.3%)	**0.030 ***
History of APH	0 (0.0%)	2 (66.7%)	**0.0006 *****
Morbidly adherent placenta at delivery	0 (0.0%)	1 (33.3%)	**0.030 ***
Fetal mortality	0 (0.0%)	1 (33.3%)	**0.030 ***

** $p \leq 0.05$; *** $p \leq 0.001$. NS = not significant. Fisher's exact test was used for all 2×2 comparisons (expected cell frequency < 5 in every case involving the mortality group); Pearson chi-square was used for the multi-category age, parity, and gravida comparisons. APH = antepartum haemorrhage; LSCS = lower segment caesarean section.*

3.7 Comparison of Continuous Parameters by Maternal Outcome

Independent-samples t-tests comparing continuous ultrasonographic and clinical parameters between the maternal mortality and survival groups are presented in Table 5. The mean placental distance from the internal cervical os at 28 weeks was significantly lower in the maternal mortality group (2.77 ± 0.64 cm) than in survivors (3.70 ± 0.64 cm; p = 0.015). The number of prior LSCS procedures was also higher in the mortality group (mean 1.33 ± 0.58 vs. 1.00 ± 0.00); because this variable takes only two values and one group had zero variance, Fisher's exact test rather than the t-test provides the valid result (p = 0.030). No statistically significant differences were observed between the two groups in maternal age (p = 0.147), gestational age at the first-trimester scan (p = 0.540), placental distance at the first-trimester scan (p = 0.076), gestational age at the anomaly scan (p = 0.823), placental distance at the anomaly scan (p = 0.458), or gestational age at delivery (p = 0.464).

Table 5. Comparison of Continuous Parameters Between Maternal Mortality and Survival Groups

Parameter	Survival (n=97) Mean ± SD	Mortality (n=3) Mean ± SD	p-value
Age (years)	25.79 ± 4.12	29.33 ± 4.51	0.147
No. of prior LSCS	1.00 ± 0.00	1.33 ± 0.58	**0.030 ***
GA at 11–14 week scan (weeks)	12.48 ± 0.79	12.77 ± 0.55	0.540
Placental distance at 11–14 weeks (cm)	3.78 ± 0.65	3.10 ± 0.36	0.076
GA at anomaly scan (weeks)	19.53 ± 0.75	19.43 ± 1.25	0.823
Placental distance at anomaly scan (cm)	3.63 ± 0.62	3.90 ± 0.53	0.458
Placental distance at 28 weeks (cm) †	**3.70 ± 0.64**	**2.77 ± 0.64**	**0.015 ***
GA at delivery (weeks)	36.61 ± 0.81	36.27 ± 0.21	0.464

** Statistically significant ($p \leq 0.05$). † Key significant finding. Independent-samples t-test, except No. of prior LSCS (Fisher's exact test; see text). GA = gestational age; LSCS = lower segment caesarean section; SD = standard deviation.*

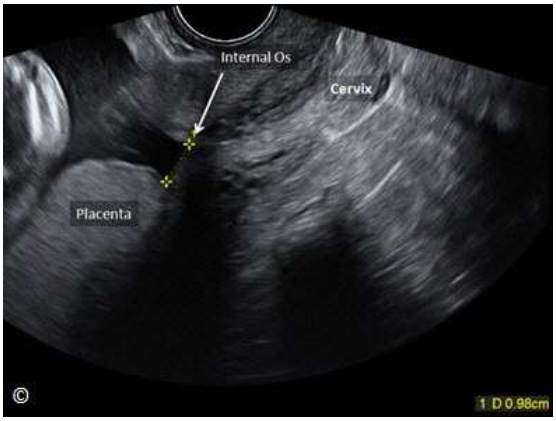

***Figure 1*:** Transvaginal ultrasound in the third trimester showing a low-lying placenta (labeled). Note that the lower edge of the placenta is about 0.9 cm from the cervical internal os (labeled). The cervix is also labeled for image orientation

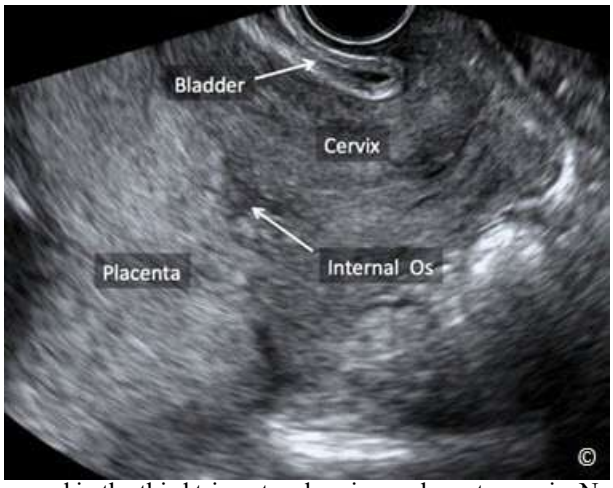

***Figure 2*:** Transvaginal ultrasound in the third trimester showing a placenta previa. Note that the placenta (labeled) is covering the cervical internal os (labeled). The bladder is seen anteriorly (labeled). The cervix is also labeled for image orientation

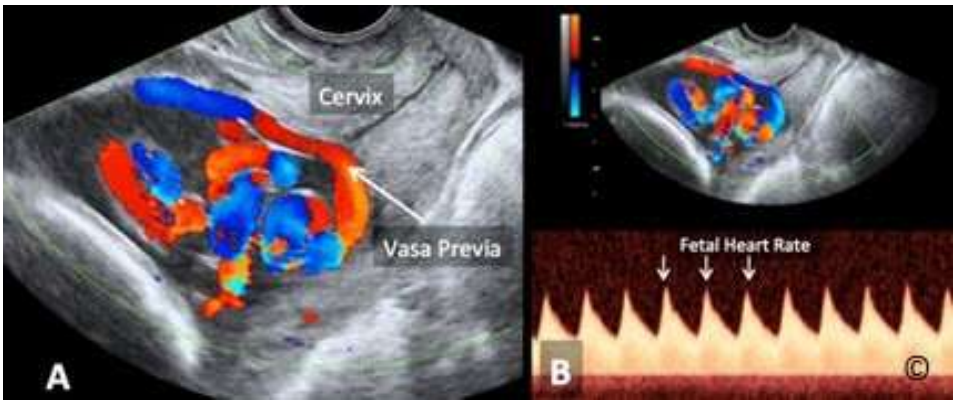

***Figure 3*:** Transvaginal colour (A) and pulsed (B) Doppler ultrasound in the third trimester demonstrating a placenta previa complicated by concurrent vasa previa. Colour Doppler mapping (A) reveals a fetal vessel crossing directly over the internal cervical os. Pulsed-wave Doppler (B) confirms the fetal origin of the aberrant vessel by documenting the fetal heart rate. This case illustrates a high-risk presentation of abnormal placentation requiring meticulous Doppler evaluation.

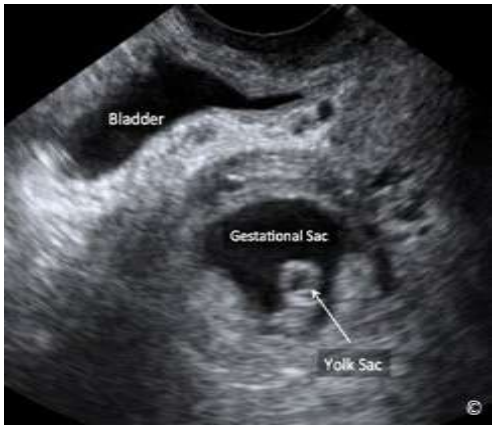

***Figure 4*:** Transvaginal ultrasound in the first trimester (11–14 weeks) demonstrating an anteriorly implanted gestational sac within the lower uterine segment overlying the prior caesarean scar. This early scar-niche implantation carries a high positive predictive value for subsequent complications; in this patient, the pregnancy progressed to a morbidly adherent placenta, which was operatively confirmed at the time of delivery.

4. DISCUSSION

This prospective observational cohort study describes the serial ultrasonographic trajectory and peripartum outcomes of 100 post-LSCS patients with anteriorly implanted low-lying placenta identified at the 11–14 week first-trimester scan. Our principal findings are four-fold: (1) anterior low-lying placenta in post-LSCS patients demonstrates markedly restricted migration across serial examinations from 11–14 weeks through 28 weeks; (2) a smaller placental distance from the internal os at 28 weeks is a significant predictor of maternal mortality; (3) retroplacental haemorrhage at the first-trimester scan, complete placenta previa, morbidly adherent placenta, antepartum haemorrhage, and ≥ 2 prior LSCS are all highly significantly associated with adverse maternal outcome; and (4) conventional demographics — age, parity, gravida, and occupational status — are not predictive of maternal mortality in this specific high-risk subgroup.

4.1 Restricted Placental Migration: A Defining Feature

A defining characteristic of our cohort was the near-complete absence of physiological placental migration. The mean placental distance from the internal cervical os changed by a net of only −0.09 cm over approximately 14 gestational weeks (3.76 cm at 11–14 weeks → 3.67 cm at 28 weeks). In uncomplicated pregnancies, 85–98% of low-lying placentas migrate to a normal position by the mid-third trimester.[7,8] This physiological process — driven by differential trophotropic growth towards the better-vascularised upper endometrium and lower uterine segment expansion — is effectively nullified in post-LSCS patients by avid trophoblastic implantation within the lower uterine segment scar.[20,21] Our data are concordant with the findings of Banerjee et al. in a tertiary Indian hospital, who documented substantially lower migration rates in a South Asian cohort compared with Western series.[19] Our study extends these data to the first-trimester period, demonstrating that placental position at 11–14 weeks is a strong predictor of third-trimester location in this group.

The clinical implication is unequivocal: a first-trimester anterior low-lying placenta in a post-LSCS patient must not be assumed to resolve spontaneously. These patients require systematic serial surveillance throughout pregnancy, with a low threshold for escalation to a tertiary centre should features of morbid placental adherence emerge.

4.2 First-Trimester Screening — Evidence Base and Our Contribution

The 11–14-week scan was historically reserved for aneuploidy screening and early fetal anatomy assessment. The literature now strongly supports its role as an early PAS risk-stratification tool in post-LSCS

pregnancies. Stirnemann et al. identified 5.7% of screened patients as high-risk based on trophoblastic overlap with the uterine scar at 11–14 weeks; the single confirmed PAS case in the screened cohort was managed with a planned delivery at 35 weeks with a favourable outcome.[13] Younesi et al. classified 17.7% of post-LSCS patients as high-risk through first-trimester criteria.[14] Calì et al. demonstrated that classical ultrasonographic signs of PAS — including loss of the clear space, placental lacunae, bladder wall interruption, and uterovesical hypervascularity — are identifiable in the majority of high-risk patients at 11–14 weeks, with an overall acceptable diagnostic accuracy for detecting all PAS subtypes.[15] Calì et al. further showed that these ultrasonographic markers increase progressively in prevalence from early first trimester onwards, confirming the dynamic nature of PAS development throughout gestation.[16] Doulaveris et al. confirmed that TVS at 11–14 weeks identifies at least three-quarters of eventual PAS cases, with scar-niche placental implantation conferring a high positive predictive value.[17] The SMFM PAS Ultrasound Marker Task Force has since published standardised consensus criteria to facilitate reliable first-trimester assessment.[18]

In our cohort, retroplacental haemorrhage at the 11–14 week scan in one patient was strongly associated with subsequent morbidly adherent placenta and maternal mortality (Fisher's exact p = 0.030). First-trimester subplacental haemorrhage likely reflects early disruption of the decidual-myometrial interface by invasive trophoblast, foreshadowing more severe PAS. By contrast, subchorionic haemorrhage — identified in two patients — was not associated with mortality. These findings suggest that the anatomical location of first-trimester haemorrhage (retroplacental vs. marginal/subchorionic) carries distinct prognostic significance in this patient population.

4.3 Third-Trimester Placental Distance as a Mortality Predictor

A key novel finding is that mean placental distance at 28 weeks was significantly lower in the maternal mortality group (2.77 ± 0.64 cm) compared with survivors (3.70 ± 0.64 cm; p = 0.015). Closer proximity of the lower placental margin to the internal cervical os correlates with a higher likelihood of partial or complete placenta previa and attendant catastrophic haemorrhage. Lauria et al. demonstrated that placental overlap of the internal os by ≥ 10 mm at 15–24 weeks predicts placenta previa at delivery with 100% sensitivity and 85% specificity.[21] Although the precise threshold for clinical decision-making at 28 weeks in post-LSCS patients has not been formally established, our data suggest that a placental distance < 3 cm at this scan warrants expedited multidisciplinary review, early delivery planning at a specialised centre, and preparation of a perioperative team including obstetric anaesthesia, interventional radiology, and a haematology-guided massive transfusion protocol.

Importantly, placental distance at 11–14 weeks (p = 0.076) and at the anomaly scan (p = 0.458) were not significantly different between groups, suggesting that the 28-week scan — rather than the first- or second-trimester scan — provides the more clinically decisive placental distance metric for predicting adverse outcome. This may reflect the stabilisation of placental implantation and the emergence of haemodynamically significant PAS features in the early third trimester.

4.4 Multiple Prior LSCS and Mortality

The single patient in our cohort with two prior LSCS died (Fisher's exact p = 0.030). This finding, though based on a numerically small subgroup (n = 1), is clinically consistent with the well-established exponential increase in accreta risk with accumulating uterine scars documented by Miller et al.[5] and the detailed morbidity data reported by Silver et al., who showed that transfusion requirements, hysterectomy rates, and intensive care admissions all

escalate significantly beyond two prior caesarean deliveries.[2] Notably, although population-level peripartum hysterectomy rates have declined over the past four decades in well-resourced settings, this decline has not been uniform across risk strata, and hysterectomy remains disproportionately concentrated among women with multiple prior caesarean deliveries and adherent placentation.[27] The current consensus from major obstetric and radiological societies — including the SMFM[18] and the Royal College of Obstetricians and Gynaecologists — recommends that all women with two or more prior LSCS and anterior low-lying placenta should be managed as high-risk, with delivery planned at a Level III/IV centre with full surgical and haematological resources available.

4.5 Antepartum Haemorrhage and Morbid Placental Adherence

History of APH was the variable most strongly associated with maternal mortality in our cohort (Fisher's exact p = 0.0006), with both patients who experienced APH subsequently dying. APH in a post-LSCS patient with anterior low-lying placenta is a sentinel event potentially heralding vascular disruption at the placenta-accreta interface or early partial placental separation. Oyelese and Smulian classified antepartum haemorrhage in patients with concurrent abnormal placentation as a major risk factor for catastrophic intraoperative haemorrhage.[1] Hudon et al. demonstrated that 90% of patients with placenta percreta lose more than 3000 mL intraoperatively and require aggressive transfusion.[23] Our data reinforce that APH in this clinical context demands immediate escalation of care to a facility with a multidisciplinary peripartum team.

Morbidly adherent placenta was confirmed ultrasonographically at 28 weeks in one patient (1%) and operatively at delivery in the same patient (1%); both were associated with maternal mortality (Fisher's exact p = 0.030). The sensitivity of grey-scale ultrasonography for PAS has been reported at approximately 77%, with a specificity of approximately 96%, a positive predictive value of 65–93%, and a negative predictive value approaching 98%.[10] Key second- and third-trimester markers include intraplacental lacunae (highest positive predictive value), loss of retroplacental clear zone, bladder wall interruption, and colour Doppler hypervascularity.[22,24,25] MRI was employed selectively in our cohort when extrauterine invasion was suspected on ultrasound, consistent with current practice guidelines advocating MRI as a complementary rather than primary modality.[11]

4.6 Clinical Practice Implications

The collective evidence from our study supports a structured three-tier ultrasonographic surveillance pathway for all post-LSCS patients with anterior low-lying placenta. At the first-trimester scan (11–14 weeks), assessment should specifically include placental implantation site relative to the scar, placental distance from the internal os, and any features of scar-niche implantation or early haemorrhage. At the anomaly scan (18–22 weeks), placental distance should be re-measured and the placenta evaluated for second-trimester PAS markers (lacunae, clear-zone loss). At 28 weeks, a dedicated placental scan should measure placental-to-os distance and comprehensively evaluate bladder wall involvement using colour Doppler. Patients with a placental distance < 3 cm from the internal os, retroplacental haemorrhage on the first-trimester scan, or any ultrasonographic features of PAS should be referred to a quaternary-level centre for planned delivery at 34–36 weeks.[4,17] Delivery planning should encompass obstetric anaesthesia pre-assessment, consent for possible hysterectomy, availability of blood products (including fresh frozen plasma at a 1:1 ratio to packed red cells in anticipated massive haemorrhage), and where resources allow, prophylactic uterine artery balloon occlusion or selective arterial embolisation.[23]

4.7 Strengths and Limitations

The principal strengths of this study are its prospective design, standardised serial multipoint ultrasonographic protocol from the first trimester, and the use of a validated high-resolution imaging platform (GE Voluson P8 with TVS). The correlation of quantitative placental distance measurements with definitive delivery outcomes adds clinical validity to the findings.

Notable limitations include a relatively small sample size (n = 100), which constrains the statistical power of subgroup analyses — particularly for the three-patient mortality group and the single patient with two prior LSCS. With only three maternal deaths, every 2×2 comparison against mortality had an expected cell frequency below 5, so Fisher's exact test rather than the chi-square approximation was required for valid inference; even so, exact p-values in this setting are imprecise and should be interpreted as indicative rather than definitive. The multi-category comparisons (age group, parity, gravida) retain similarly sparse cells for which no exact alternative was readily available, and their reported chi-square p-values should be regarded as approximate. The single-centre design introduces referral bias inherent to a tertiary care institution. The study was conducted over eight months, which may have attenuated recruitment and affected the spectrum of presentations. Formal interobserver reliability indices for ultrasonographic measurements were not prospectively collected. The absence of independent histological confirmation of PAS diagnosis in all cases is a further constraint. A multicentre prospective study with a larger sample, standardised SMFM-criteria-based first-trimester screening, and histopathological correlation would be necessary to validate the diagnostic thresholds identified in this study and to develop a robust predictive model.

5. CONCLUSION

Anterior low-lying placenta overlying a prior lower segment caesarean section scar exhibits markedly restricted physiological migration throughout pregnancy, persisting into the third trimester in the vast majority of affected patients. This finding underscores that a first-trimester diagnosis of anterior low-lying placenta in post-LSCS women should not be managed expectantly without serial ultrasonographic follow-up. Retroplacental haemorrhage at the first-trimester scan, a smaller placental distance from the internal cervical os at 28 weeks, complete placenta previa, morbidly adherent placenta, antepartum haemorrhage, and a history of multiple prior LSCS are all significant predictors of adverse maternal outcome in this high-risk population. These findings collectively support the integration of targeted 11–14-week placental surveillance as a standard component of antenatal care for all women with prior caesarean delivery. Early identification, timely referral to a specialised centre, and multidisciplinary delivery planning remain the cornerstones for reducing preventable maternal and fetal mortality in this population.

Declaration by Authors

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