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Early Prediction of Placenta Accreta Spectrum in Women with Prior Cesarean Delivery Using Transvaginal Ultrasound and Color Doppler at 11 To 14 Weeks

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ABSTRACT

Background: Placenta accreta spectrum (PAS) is a life-threatening obstetric condition connected with prior cesarean delivery and abnormal placental adherence. Early detection is crucial to reduce maternal morbidity and for guiding delivery planning. Although diagnosis is commonly made in the third trimester, there is growing evidence that first-trimester ultrasound may help predict PAS in high-risk women.

Objective: This study aimed to estimate the screening performance of transvaginal ultrasound (TVS) and color Doppler performed at 11–14 weeks of gestation for early expectation of placenta accreta spectrum (PAS) in women with previous cesarean deliveries.

Patients and Methods: In this prospective observational study, 63 pregnancies with one or more prior cesarean deliveries (CDs) underwent TVS and color Doppler to evaluate placental location and its relationship to the uterine scar. Patients were followed until delivery, and PAS diagnosis was confirmed surgically and histopathologically when applicable.

Results: Ultrasound demonstrated a sensitivity of 88% and a specificity of 95% in predicting PAS. Group II (those with suspicious ultrasound findings) showed significantly higher rates of histologically confirmed PAS (20%; $p = 0.004$), cesarean hysterectomy (44%; $p < 0.001$), and preterm birth ($p < 0.05$). Ultrasound markers such as placental lacunae, myometrial thinning, and bridging vessels were significantly associated with PAS.

Conclusion: First-trimester transvaginal ultrasound and color Doppler are effective early screening tools for PAS in women with prior cesarean deliveries, allowing timely risk stratification and multidisciplinary management to reduce maternal and neonatal complications.

Keywords: Placenta accreta spectrum, Transvaginal ultrasound, Cesarean delivery, First-trimester screening

INTRODUCTION

PAS is a perilous obstetric syndrome arising from the incomplete separation of the placenta from the uterus during birth [1]. PAS may result in significant maternal difficulties like bleeding, blood transfusion requirements, hysterectomy, coagulopathy, surgical damage to neighboring organs, and mortality, with detrimental perinatal outcomes involving preterm birth and its related neonatal consequences [2].

The prevalence of PAS has risen consistently from roughly one in thirty thousand deliveries in the 1950s to three in one thousand deliveries in the last decade [3].

This was ascribed to the substantial rise in the incidence of CDs, a recognized risk factor for placental accreta spectrum, over recent decades. Prenatal identification of placental accreta spectrum, primarily conducted via ultrasound in the 3rd trimester, facilitates surgical planning in specialized clinics and was linked to enhanced results, decreasing morbidity by fifty percent [4,5]. Nevertheless, diagnosis in the 3rd trimester is suboptimal and often does not provide sufficient time for surgical planning; hence, the majority of cases are still misdiagnosed until delivery. A burgeoning body of proof indicates that sonographic indicators of PAS may be detectable as early as the 1st trimester of gestation. A cesarean scar pregnancy (CSP) is identified as a precursor to placenta accreta spectrum, indicating that the aberrant attachment of the placenta to the uterine scar begins early in gestation, and, if unaddressed, a cesarean scar pregnancy may culminate in a live birth accompanied by placenta accreta spectrum [6].

The study aimed to evaluate the screening efficacy of transvaginal sonography and color Doppler performed at 11–14 weeks of gestation in women with a previous cesarean delivery for the early expectation of PAS.

PATIENTS AND METHODS

This prospective cross-sectional observational study included 63 pregnant women between 11 and 14 weeks of gestation, recruited from Menoufia University Hospital and El Shohda Central Hospital (affiliated with the Egyptian Ministry of Health). The study was conducted between May 2023 and April 2025.

Patient Recruitment and Follow-up:

Upon enrollment, patients underwent an initial assessment and were closely followed throughout pregnancy until cesarean delivery. Their progress was monitored through scheduled follow-up visits and additional assessments when necessary to ensure the collection of comprehensive and reliable data.

Patients were divided into two groups based on placental TVS grading and were compared for maternal and neonatal outcomes according to the three placental grades. **Group I** included cases with no suspicion of PAS (G0), and **Group II** included cases with intermediate or high suspicion of PAS (G1 and G2).

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Inclusion criteria: Multipara pregnant women with a single viable fetus with gestational age (GA) between 11 and 14 weeks, with one or more previous cesarean deliveries.

Exclusion criteria: Patients who did not complete follow-up until delivery **or experienced** fetal loss**;** patients with congenital uterine anomalies or with previous uterine scars other than CDs**;** patients with chronic medical conditions or pregnancy-related complications **(e.g.,** gestational hypertension [GHT], gestational diabetes mellitus [GDM]**);** and those with multifetal pregnancies.

Procedures:

Ultrasound Procedures:

Each patient underwent both a transvaginal ultrasound (TVS) and Doppler ultrasound, performed by the same experienced radiologist to ensure consistency. The transvaginal ultrasound was performed utilizing the Voluson E10 (GE Healthcare, Milwaukee, WI) endovaginal probe (five to nine megahertz).

The procedures performed during ultrasound involved:

Crown-Rump Length (CRL) Measurement: Used to confirm gestational age and assist with dating the pregnancy.

Placental Localization: Assessing the site of the placenta in relation to the uterine scars.

Identification of Cesarean Delivery Scars: A transvaginal ultrasound was performed to identify the site of the cesarean scar and assess its relationship with the placenta. If the placenta has been found to be in close proximity to the scar, additional images have been taken to further evaluate the placental location in relation to the scar niche.

The ultrasound assessments included evaluating for specific features indicative of a potential PAS, as outlined by the Society for Maternal-Fetal Medicine (SMFM)**. These features include the** presence of placental lakes, low implantation of the gestational sac (below four centimeters from the external os), and disruption of the placental-myometrial interface. Trophoblast encroaching onto the CD scar, along with intraplacental dilated arteries, turbulent flow of blood, and heightened periplacental vascularity observed via Doppler ultrasound.

Ultrasound Grading System: The placental relationship to the cesarean scar was characterized into one of three grades:

Grade 0 (G0): No suspicion of PAS, with the placenta located far from the scar.

Grade 1 (G1): Intermediate suspicion of placenta accreta spectrum, with the placenta situated next to or on the scar without infiltrating the scar niche.

Grade 2 (G2): High suspicion of placenta accreta spectrum, with the placenta implanted inside the scar niche.

Patient Follow-up: Patients were followed up throughout their pregnancy, and the final diagnosis of PAS (including increta, placenta accreta, or percreta) was made by the attending surgeon at the delivery time. This diagnosis was based on intraoperative findings according to the International Federation of Gynecology and Obstetrics (FIGO) criteria, which include:

- **Failure of placental separation** after administration of synthetic oxytocin and gentle cord traction.
- **Difficulty in manual removal of the placenta**, often associated with significant hemorrhage from the implantation site.
- **Abnormal macroscopic findings** in the placental bed, such as purple or bluish discoloration and marked hypervascularity.

Histopathological Confirmation: In cases where the placenta was removed, histopathological examination of the uterus and placental bed was performed to further confirm PAS. The criteria used for PAS diagnosis included:

Placenta Accreta: Absence of decidua with placental villi attached directly to the superficial myometrium.

Placenta Increta: Placental villi extending into the muscular fibers of the myometrium.

Placenta Percreta: Placental villi penetrating through the uterine serosa and possibly reaching the bladder wall.

Ethical Consideration:

The study protocol was approved by the Institutional Review Board of Menoufia University. Ethical approval was also obtained from the Ethical Committee of Menoufia Faculty of Medicine. Each participant provided written informed consent. Confidentiality and personal privacy were maintained at all stages of the study. Participation was voluntary, and each patient had the right to withdraw at any time. Anonymity was ensured by coding participant data. The study was conducted in accordance with the Declaration of Helsinki.

Statistical Analysis

The collected data have been processed, encoded, and analyzed using the SPSS version 21.0 for Windows. Descriptive statistics have been determined to involve means, medians, standard deviations, percentages, and ranges. Independent t-tests have been performed to compare the means of regularly distributed continuous parameters. The Student's T-Test has been applied to estimate the statistical significance of the variance in parametric variables among the means of two study groups. The Mann-Whitney U test has been applied to estimate a statistically significant variance in a non-parametric variable among 2 research groups. The chi-square test has been utilized to analyze the association among 2 categorical parameters. A p-value below 0.05 is regarded as statistically significant.

RESULTS

Table 1 illustrates that there was no statistical variance regarding age and BMI.

Table (1): Distribution of baseline characteristics data among examined groups.

	Group I (G0) Num.=38	Group II (G1,2) Num.=25	P value
Age (year) Mean ± SD	31.5± 4.5	31.68± 4.34	0.87
BMI (kg/m^2) Mean ± SD	29.13±7.57	31.04± 7.68	0.33

A p-value below 0.05 is statistically significant; a p-value above 0.05 is not significant; a p-value below 0.001 is highly significant; SD: standard deviation.

Table 2 shows that there was statistical variance regarding the number of prior cesarean births, while there was no statistical difference regarding gestational age at ultrasound, history of previous uterine surgery, and history of previous preterm cesarean.

Table (2): Distribution of Patient Characteristics among examined groups.

		Group I (G0) Num.=38	Group II (G1,2) Num.=25	P value
Gestational Age at Ultrasound Mean ± SD		12.05± 0.98	12.08± 0.75	0.89
Number of Prior Cesarean Births Mean ± SD		1±0	1.24± 0.43	0.001
History of Prior Uterine Surgery	Yes (N%)	8 (21%)	2 (8%)	0.16
	No (N%)	30 (79%)	23 (92%)	
History of Prior Preterm Cesarean	Yes (N%)	7 (18.4%)	4 (16%)	0.06
	No (N%)	31(81.6%)	21 (84%)	

Table 3 illustrates that there was statistical variance according to histopathological identification of placenta accreta spectrum, planned delivery by the placenta accreta spectrum team, taking of antenatal corticosteroids, cesarean hysterectomy, preterm delivery, and transfusion of blood products, while there was no statistical variance regarding mode of delivery.

Table (3): Distribution of Gestational outcomes among examined groups.

		Group I (Num.=38)	Group II (Num.=25)	P value
Histopathological Diagnosis of PAS		0 (0%)	5 (20%)	**0.004**
Planned delivery by PAS team		0 (0%)	8 (32%)	**<0.001**
Cesarean Hysterectomy		0 (0%)	11 (44%)	**<0.001**
Administration of Antenatal Corticosteroids		2 (5.3%)	11 (44%)	**<0.001**
Preterm delivery		5 (13.15%)	10 (40%)	**0.01**
Mode of Delivery	Cesarean	36 (97.7%)	25 (100%)	0.2
	Vaginal	2 (5.3%)	0 (0%)	
Transfusion of Blood Products		2 (5.3%)	13 (52%)	**<0.001**

Table 4 illustrates that there was statistically insignificant variance among the examined group regarding Apgar score and admission to the newborn intensive care unit. While a statistically significant variance has been observed between the examined groups regarding gestational age.

Table (4): Distribution of neonatal outcome among examined groups.

	Group I (Num.=38)	Group II (Num.=25)	P value
Gestational Age at Birth Mean ±SD	37.5 ±0.55	36.32 ±1.31	**<0.001**
Apgar score Mean ±SD	8.5 ±1.2	7.92 ±1.5	0.09
Admission to neonatal intensive care unit	4 (10.5%)	6 (24%)	0.15

This table compares ultrasound signs predictive of placenta accreta at 11–14 weeks between two groups: Group I (38 women with normal placentation) and Group II (25 high-risk women). The analysis shows that signs such as low gestational sac implantation, loss of the retroplacental clear zone, irregular placental-myometrial interface, presence of placental lacunae, myometrial thinning, subplacental hypervascularity, exophytic placental tissue, with P-values < 0.05. These findings suggest that certain first-trimester ultrasound markers can be early indicators of abnormal placental invasion, emphasizing the importance of early screening in high-risk pregnancies to allow timely diagnosis and management of placenta accreta (Table 5).

Table (5): Distribution of Ultrasound finding among studied groups.

Ultrasound Sign	Group I (Normal) N=38	Group II N=25 total)	P-value
Low implantation of gestational sac	4 (10.5%)	9 (36.0%)	0.014
Loss of retroplacental clear zone	2 (5.3%)	8 (32.0%)	0.009
Irregular placental-myometrial interface	1 (2.6%)	7 (28.0%)	0.007
Placental lacunae (vascular spaces)	1 (2.6%)	6 (24.0%)	0.017
Myometrial thinning (<1 mm)	0 (0.0%)	5 (20.0%)	0.009
Subplacental hypervascularity (Color Doppler)	1 (2.6%)	6 (24.0%)	0.017

P value >0.05: Not significant, P value <0.05 is statistically significant, p<0.001 is highly significant.

Ultrasound had a sensitivity of 88% and a specificity of 95% with high significance for the detection of placenta accrete (Table 6).

Table (6): ROC analysis for ultrasound for the detection placenta accreta.

Test Result Variable(s)	Area	Sensitivity	Specificity	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
						Lower Bound	Upper Bound
US	0.914	88%	95%	0.044	0.000	0.828	0.999

DISCUSSION

Our research illustrated that there was no statistical variance according to age and BMI. In agreement with our research **Hu *et al.*** [7], which aimed to determine the clinical risk factors and 1st trimester ultrasound signs correlated with severe placenta accreta spectrum, they stated that there was insignificant variance among the Mild group and the Severe group regarding maternal age and BMI.

Our research illustrated that there was statistical variance according to the number of prior cesarean births, while there was no statistical difference regarding gestational age at ultrasound, history of previous uterine surgery, and history of previous preterm cesarean.

In agreement with our research, **Thiravit *et al.*** [8] found that there was insignificant variance between cases with severe PAS and patients with no severe PAS regarding previous uterine surgery.

Our study illustrated that there was statistically significant variance regarding histopathological identification of PAS, planned delivery by the placenta

accreta spectrum team, taking of antenatal corticosteroids, cesarean hysterectomy, preterm delivery, and transfusion of blood products, while there was statistically insignificant variance regarding mode of delivery.

In agreement with our research, **Thiravit *et al.*** [8] found that there was significant variance among cases with the severe PAS group and patients with no severe PAS group.

Also, in agreement with our research, **Skupski *et al.*** [9] stated that regarding mode of delivery, 161 (78.5%) had Cesarean delivery and 44 (21.5%) patients had vaginal delivery.

Our study illustrated that there was statistically insignificant variance among the studied group regarding Apgar score and admission to the newborn intensive care unit. While there was statistically significant variance among the studied group regarding gestational age.

In agreement with our research, **Cali *et al.*** [10] found that the mean gestational age at delivery was 35.3 ± 1.7 and the mean admission to ICU was 8.6%.

Also, in agreement with our study, **Abdelazeem *et al.*** [11] who aimed to estimate the value of uterine artery Doppler velocimetry in suspecting PAS in cases with placenta previa,stated that the mean gestational age was 37.4±0.5.

In contrast with our study **Skupski *et al.*** [9] they found that the mean admission to ICU was 3.9%, which was much less than our ICU admission distribution.

Our research illustrated that there was statistically significant variance among the examined group regarding the ultrasound findings of placental lacunae, loss of hypoechoic retroplacental zone, myometrial thinning (below one millimeter), bladder wall interruption, subplacental vascularity, bridging vessels.

In agreement with our study, **El-Sayed *et al.*** [12] aimed to estimate the effectiveness of 2D color Doppler, grey-scale ultrasound, and 3D power Doppler sonographic indicators in expecting major blood loss throughout the operation for patients identified with PAS disorders. They stated that a statistically significant variance was observed between minor and major groups according to ultrasound findings of placental lacunae, myometrium thinning, vessel bridging, and hypoechoic area.

Our research illustrated that the ultrasound had a sensitivity of 88% and a specificity of 95% with high significance for the detection of placenta accreta.

According to **Rahimi-Sharbaf *et al.*** [13] who aimed to determine the accuracy of ultrasound outcomes for placenta accreta in the 1st trimester of gestation, the ultrasound specificity and sensitivity for identifying placenta accreta in the 1st trimester were eighty-eight percent [95% CI: 88.2-94.6] and forty-one percent [95% CI: 16.2-62.7], respectively.

CONCLUSION

The study underscores the imperative of early detection and intervention strategies in the management of placenta accreta spectrum (PAS) cases. Through meticulous analysis of patient data and diagnostic modalities, the study demonstrates the efficacy of first-trimester ultrasound screenings in identifying PAS, providing valuable insights into risk stratification and management approaches. The findings highlight the pivotal role of comprehensive prenatal care and interdisciplinary collaboration in reducing the risks associated with PAS and improving maternal-fetal outcomes. By integrating cutting-edge diagnostic modalities with multidisciplinary collaboration, healthcare providers optimize patient care pathways and enhance the quality of care for women at risk of PAS.

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