



DESIGNING A SCORING MODEL FOR PLACENTA ACCRETA PREDICTION : EVALUATING PREDICTION ACCURACY

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Abstract

Objective:

To evaluate the diagnostic accuracy of a combined clinical and ultrasonographic scoring model for predicting placenta accreta spectrum (PAS) in high-risk pregnancies.

Methods:

This open-label randomized controlled trial conducted at Department of Gynecology and Obstetrics of Jinnah Postgraduate Medical Centre, Karachi from 16 June, 2024 to 17 September, 2024. The research was a prospective cohort study involving 323 pregnant women whose gestation was at least 18 weeks Longo and met preset criteria of PAS risks. The maternal demographics, obstetric history and seven standardized ultrasound parameters were documented. A scoring system (range: 018) was used to categorize women as low-risk (03) and high-risk (4 and above). Statistical analysis comprised of logistic regression and ROC curve analysis with $p < 0.05$ as significant.

Results:

PAS was validated in 68 women (21.1%). Prior caesarean delivery ($p < 0.001$), placenta previa ($p < 0.001$), and a short interpregnancy interval ($p = 0.002$) were significantly more prevalent in PAS cases. Severe placental lacunae (79.4% vs. 18.4%), myometrial thickness < 1 mm (63.2% vs. 8.6%), and marked uterovesical hypervascularity (58.8% vs. 11.4%) exhibited a significant association with PAS (all $p < 0.001$). The scoring model accurately identified 92.6% of PAS cases as high-risk, in contrast to 18.4% of non-PAS cases ($p < 0.001$). Logistic regression identified severe lacunae (OR 5.87), myometrial thinning (OR 4.94), and placenta previa (OR 3.21) as independent predictors. ROC analysis demonstrated exceptional discriminatory capacity, yielding an AUC of 0.92 (95% CI: 0.88–0.96), sensitivity of 92.6%, specificity of 81.5%, positive predictive value of 63.4%, and negative predictive value of 96.9%.

Conclusion:

The combined clinical ultrasound scoring system has a high accuracy in diagnosis to predict PAS, and it has a high sensitivity and discriminative ability. Its systematic, replicable measurement can aid in its earlier discovery, enhanced surgical planning and enhanced maternal outcomes, especially in low resource facilities.

Keywords:

Placenta accreta spectrum, ultrasound scoring model, diagnostic accuracy, placenta previa, cesarean section, obstetric ultrasound.

INTRODUCTION

Placenta accreta spectrum (PAS) is one of the most difficult obstetric emergencies today as the number of such cases grows continuously over the last several decades. This has to do with an increase in rates of cesarean births and uterine surgery. PAS has been on the rise in the recent years, and there is an urgent necessity to detect and properly stratify the risks to avoid serious morbidity and mortality of the mother [1–3]. PAS is characterized by the abnormal placental adherence or intrusion to the myometrium, which may lead to life-threatening issues (such as massive obstetric haemorrhage, disseminated intravascular coagulation, and peripartum hysterectomy) [4]. Although the imaging methods have improved, this has not decreased the diagnostic variability because of operator-specific ultrasound observations and variability in interpretation [5]. Color Doppler ultrasound is the mainstay of antenatal diagnosis, and recent research has shown that such specific indicators as placental lacunae, myometrial thinning, and uterovesical hypervascularity can be used to increase the potential of the methodology [6]. Nonetheless, the predictive power of ultrasound can be less in resource constrained conditions of limited skills and technology [7]. Existing data holds a lot of weight in favor of the fact that previous cesarean section, placenta previa, short age of inter-pregnancy, and other procedures that involve the uterus are among the greatest predictors of PAS. It has also been proposed in the recent literature that the strengths of the relationship between maternal age and the increased use of assisted reproductive technologies might also be contributing to the increased incidence [8,9]. These changing aspects emphasize the importance of broad and context specific predictive models. Late presentation and access to standardized screening also contribute to the further complicated detection of early PAS in low and middle-income countries (LMIC) contributing to disproportionately high maternal morbidity and mortality [10]. This has seen an increasing interest in coming up with simple, reliable scoring systems that can be used to integrate maternal risk factors with sonographic characteristics that can enhance early detection. This study will attempt to assess the accuracy of the diagnoses of a structured clinical ultrasound-based scoring model in predicting PAS. The study provides a practical way of improving the prenatal risk stratification in populations with high disease burden.

METHODOLOGY

This prospective cohort study was carried out at the Department of Gynecology and Obstetrics of Jinnah Postgraduate Medical Centre (JPMC), Karachi, 16 June, 2024 to 17 September, 2024. The study duration was 18 months. Pregnant women at or after 18 weeks gestation with a clinical suspicion of morbidly adherent placenta (MAP) were consecutively selected by using a probability sampling technique. Pregnant women who had at least one risk factor, including previous cesarean delivery, previous miscarriage or abortion, previous dilation and curettage, myomectomy, endometrial ablation or any other uterine surgery, and placenta previa in the current or previous pregnancy were included in the study. The exclusion criteria were primigravida, fetal growth restriction, congenital malformations or intrauterine fetal death, uterine conditions that may affect ultrasound quality, such as leiomyoma, malignancy, or any other structural uterine lesion, placental abruption, or requirement of an emergency surgery without sonographic evaluation. The sample size for the study was calculated using OpenEpi (Version 3), with 95% confidence interval (CI) and a 5% margin of error. The minimum calculated sample size for the study was 323. Data regarding the demographic and obstetric characteristics of the patients, such as maternal age, BMI, gravidity, parity, gestational age, type and number of previous deliveries, previous history of miscarriage and dilation and curettage, interpregnancy interval, placental location, and medical comorbidities including hypertension and diabetes mellitus, were recorded. All ultrasound investigations were performed by trained sonologists, using Samsung color Doppler and Doppler units provided by TİKA. Transabdominal (3–5 MHz) and transvaginal probes (3–9 MHz) were used according to the location of the placenta. Seven

ultrasonographic parameters, including placental lacunae, uterine wall site of attachment of the placenta, uterovesical vascularity, myometrial thickness and the status of retroplacental hypoechoic zone, bladder line, cervical length, and previous history of cesarean delivery, were used. The ultrasonographic variables were a cumulative scoring system with a maximum score of 18. The participants were divided into low-probability of PAS (score ≤ 3) and high-probability of PAS groups (score ≥ 4). The categorical and continuous variables were described using frequencies and percentages, and mean $\pm$ SD, respectively. Univariate testing was performed using the Chi-square and Kruskal–Wallis tests. Variables with significant results were subjected to multivariate analysis using logistic regression models. The Receiver Operating Characteristic (ROC) curve was used to evaluate the diagnostic performance of the scoring system for predicting the risk of PAS in the study population. Sensitivity, specificity, and area under the curve (AUC) were calculated. All statistical analyses were performed using the SPSS version 22.0 (IBM Corp., Armonk, N.Y., USA). The p-value was considered significant at <0.05 .

RESULTS

The study included 323 pregnant women, 68 of whom (21.1%) were confirmed to have placenta accreta spectrum (PAS), and 255 of whom (78.9%) were in the non-PAS comparison group. Table 1 shows a summary of the mother's baseline characteristics. Women with PAS had significantly more previous caesarean deliveries compared to the non-PAS group (2.1 ± 0.8 vs. 0.9 ± 0.6 , $p < 0.001$), and placenta previa was observed more frequently among PAS cases (72.0% vs. 31.8%, $p < 0.001$). A brief interpregnancy interval (<18 months) correlated with an increased prevalence of PAS (44.1% vs. 23.9%, $p = 0.002$), and a history of dilation and curettage was more prevalent among PAS patients (39.7% vs. 20.8%, $p = 0.001$). Table 2 shows how ultrasound parameters are spread out. Severe placental lacunae (Grade 3–4) were observed in 79.4% of PAS cases compared to 18.4% of non-PAS cases ($p < 0.001$), as further depicted in Figure 2. Marked myometrial thinning (<1 mm) accompanied by the loss of the retroplacental clear zone exhibited a significant association with PAS (63.2% vs. 8.6%, $p < 0.001$). There was a strong link between loss or irregularity of the bladder line and PAS (58.8% vs. 11.4%, $p = 0.001$). There was also a strong link between marked uterovesical hypervascularity and PAS (58.8% vs. 11.4%, $p = 0.001$). A cervical length of less than 1 cm showed a moderate but significant link (27.9% vs. 9.0%, $p = 0.001$). Using the cumulative scoring model, 92.6% of PAS cases were in the high-risk group (score ≥ 4), while only 18.4% of non-PAS cases were in that group ($p < 0.001$), as shown in Table 3. Multivariate logistic regression identified severe lacunae (OR 5.87, 95% CI 3.12–11.05, $p < 0.001$), myometrial thickness <1 mm (OR 4.94, 95% CI 2.40–8.91, $p < 0.001$), and placenta previa (OR 3.21, 95% CI 1.65–6.12, $p = 0.001$) as independent predictors of PAS, presented in Table 4. Diagnostic accuracy testing demonstrated excellent model performance with an AUC of 0.92 (95% CI 0.88–0.96, $p < 0.001$), illustrated in Figure 1, and at a cutoff score ≥ 4 , the sensitivity was 92.6%, specificity 81.5%, positive predictive value 63.4%, and negative predictive value 96.9%. These results together show that the clinical-ultrasound scoring system is very good at predicting PAS.

Table 1. Baseline Characteristics of Study Participants

Variable	PAS (n=68)	Non-PAS (n=255)	p-value
Maternal age (years)	30.8 ± 5.4	29.6 ± 5.1	<0.05
Previous C-section	2.1 ± 0.8	0.9 ± 0.6	<0.001
Placenta previa (%)	72.0%	31.8%	<0.001
IPI <18 months (%)	44.1%	23.9%	0.002

Table 2. Distribution of Ultrasound Findings

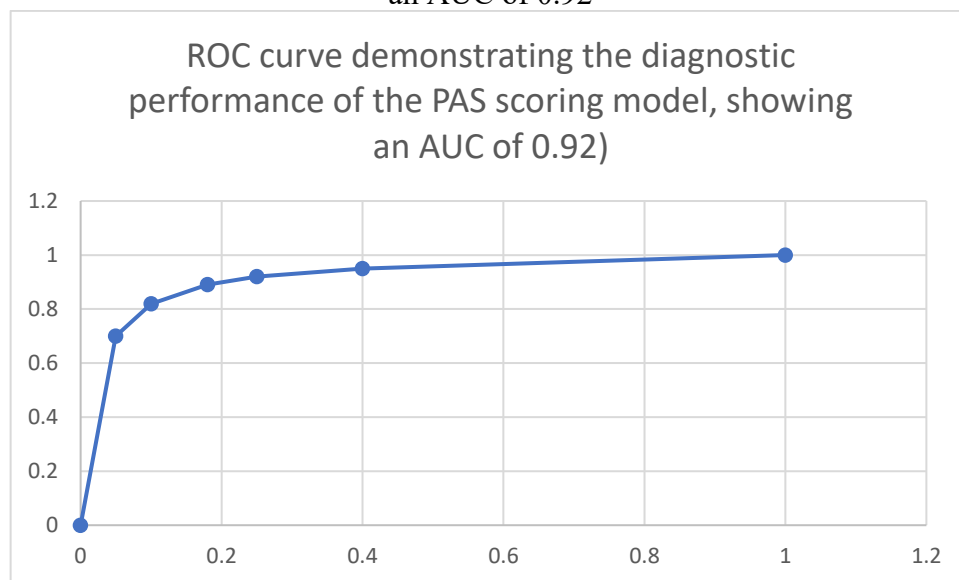
Ultrasound Parameter	PAS (%)	Non-PAS (%)	p-value
Severe lacunae (Grade 3–4)	79.4%	18.4%	<0.001
Myometrial thickness <1 mm	63.2%	8.6%	<0.001
Hypervascularity (Grade 3)	58.8%	11.4%	<0.001
Bladder line irregular/lost	70.6%	20.0%	<0.001

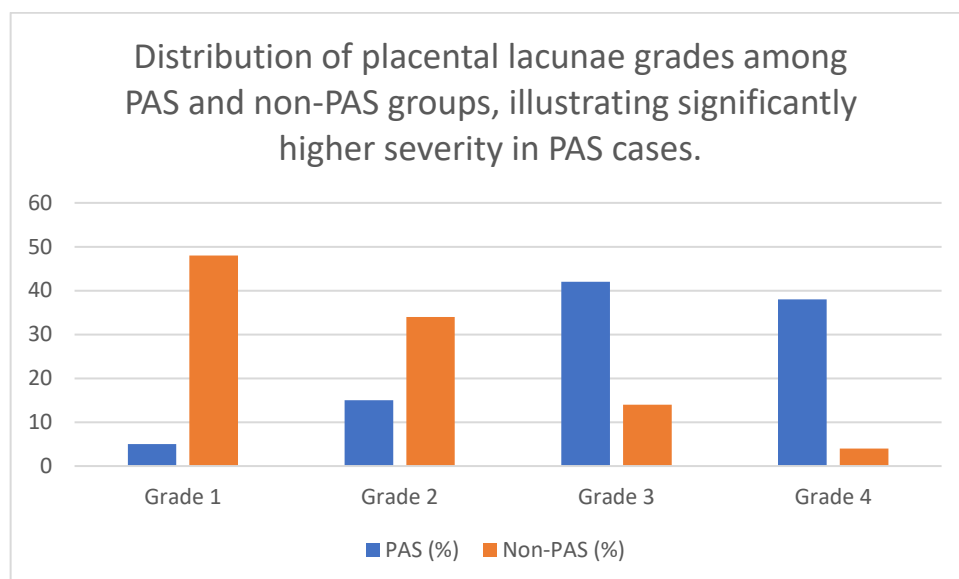
Table 3. PAS Scoring Model Performance

Score Category	PAS (n=68)	Non-PAS (n=255)	p-value
Low risk (≤ 3)	7.4%	81.6%	<0.001
High risk (≥ 4)	92.6%	18.4%	<0.001

Table 4. Multivariate Logistic Regression for Predictors of PAS

Predictor	Odds Ratio	95% CI	p-value
Severe lacunae	5.87	3.12–11.05	<0.001
Myometrium <1 mm	4.94	2.40–8.91	<0.001
Placenta previa	3.21	1.65–6.12	0.001

Figure 1: ROC curve demonstrating the diagnostic performance of the PAS scoring model, showing an AUC of 0.92**Figure 2:** Distribution of placental lacunae grades among PAS and non-PAS groups, illustrating significantly higher severity in PAS cases.



DISCUSSION

In this prospective study, the combined clinical and ultrasonographic scoring system exhibited excellent diagnostic accuracy in predicting PAS, suggesting its utility as an early risk-stratification tool for antenatal care. The prevalence of PAS in our cohort (21.1%) is consistent with recent reports from other high-burden centers, where an increasing cesarean section rate and short birth intervals have created the most dangerous obstetric risk profile [11]. In agreement with previous studies, women with PAS in the present analysis had significantly higher rates of prior cesarean delivery and placenta previa, which are known to have an additive or multiplicative cumulative effect via uterine scarring and aberrant placentation pathways [12,13]. One of the strongest associations in our study was the presence of severe placental lacunae and PAS, with nearly four of five women affected having grade 3–4 lacunae. This is similar to current studies showing that lacunar severity is one of the most reliable sonographic criteria of abnormal invasion, especially when multiple confluent vascular spaces distort the normal placental architecture [14]. The other highly predictive factors in our analysis were myometrial thinning (<1 mm) and loss of the retroplacental clear zone, which are in line with evidence that the breakdown of the decidua basalis–myometrial interface is the fundamental pathological event of invasive placentation [15]. Similarly, marked uterovesical hypervascularity was highly associated with PAS, which is consistent with earlier Doppler-based studies that demonstrated extensive bridging vessels and chaotic neovascularization are characteristic of severe disease [16]. The scoring model in our study had an AUC of 0.92, which is in the excellent discrimination range. This is aligned with other more organized scoring frameworks which have been proposed over the last few years with most of them highlighting the necessity of incorporating maternal risk factors as well as objective imaging criteria to reduce variability that is operator dependent [17,18]. We set a ≥ 4 score cutoff, resulting in an NPV that is significantly high, indicating that low-risk patients should not be offered PAS, and this finding is clinically useful, particularly in the low-resource environment where an unjustified referral may overburden the tertiary care hospital [19]. The PPV was not large, but this is to be expected of a population-based screening model, and it highlights that any screening score has no substitute but a complement to expert ultrasound interpretation.

Our findings suggest that a simple, standardized, and reproducible scoring system can aid earlier recognition of high-risk patients, facilitate multidisciplinary team planning and counseling, ensure blood product availability, and permit operative preparedness, all of which are known to lower maternal morbidity and mortality from PAS [20]. The strengths of our study included its prospective

design, comprehensive ultrasound evaluation, and incorporation of various maternal risk factors. However, the limitations of our study include potential operator experience, single-center design, and lack of comparison to MRI, and are consistent with other challenges identified in similar work across the region [21]. Future multicenter validation studies are needed to help refine cutoff values, test inter-observer reliability, and evaluate possible integration with advanced Doppler indices or machine-learning-based models for improved prediction.

Conclusion:

This study demonstrates that a combined clinical and ultrasonographic scoring model provides a highly accurate method for predicting placenta accreta spectrum in high-risk pregnancies. The high correlation between the most important ultrasound markers, especially severe placental lacunae, myometrial thinning, and uterovesica hypervascularity, and the confirmed PAS indicates the importance of the structured assessment, rather than the subjective one. The scoring system has good discriminatory performance, and it allows the early detection of risks and facilitates the planning of the multidisciplinary team in time. This model can be implemented in everyday obstetric care, particularly in resource constrained systems, to decrease the number of complications by enhancing readiness and focus on women at greatest risk.

REFERENCE

1. Jauniaux E, Bunce C, Grønbeck L, Langhoff-Roos J. Prevalence and main outcomes of placenta accreta spectrum: a systematic review and meta-analysis. *Am J Obstet Gynecol.* 2019;221(3):208–18.
2. Thurn L, Lindqvist PG, Jakobsson M, Colmorn LB, Klungsoyr K, Bjarnadóttir RI, et al. Abnormally invasive placenta—prevalence, risk factors and antenatal suspicion: results from a large population-based cohort study. *BJOG.* 2020;127(11):1465–73.
3. Cali G, Timor-Tritsch IE, Palacios-Jaraquemada J, et al. Abnormal uteroplacental vascularity and PAS: updated diagnostic criteria. *Prenat Diagn.* 2022;42(5):531–9.
4. Nair M, Kurinczuk JJ, Knight M. Establishing causes of maternal morbidity: methodological challenges and solutions. *Lancet.* 2021;398(10303):199–210.
5. D'Antonio F, Iacovella C, Bhide A. Prenatal identification of invasive placentation using ultrasound: systematic review and meta-analysis. *Am J Obstet Gynecol.* 2018;219(1):62.e1–62.e16.
6. Jauniaux E, Ayres-de-Campos D; FIGO Placenta Accreta Diagnosis and Management Expert Consensus Panel. FIGO guidelines on PAS. *Int J Gynaecol Obstet.* 2019;146(S1):1–24.
7. Tseng JJ, Chou MM, Hsu SL, Ho ES. A simplified scoring model for prenatal prediction of PAS. *Placenta.* 2020;95:40–6.
8. Maso G, D'Ottavio G, De Seta F. Advanced maternal age and complications including PAS: updated review. *J Matern Fetal Neonatal Med.* 2021;34(18):2950–6.
9. Jha P, Waghdhare S, Singh N. Assisted reproductive technologies and placental abnormalities: risk patterns. *Int J Gynaecol Obstet.* 2020;151(2):216–22.
10. Boerma T, Ronsmans C, Melesse DY, et al. Global epidemiology of cesarean section. *PLoS Med.* 2018;15(12):e1002670.
11. Silver RM, Fox KA, Barton JR, et al. Center of excellence for placenta accreta spectrum: SMFM recommendations. *Am J Obstet Gynecol.* 2021;224(6):B2–B16.
12. Jauniaux E, Ayres-de-Campos D. FIGO consensus guidelines on placenta accreta spectrum disorders. *Int J Gynaecol Obstet.* 2019;146(1):1–19.
13. Thurn L, Lindqvist PG, Colmorn LB, et al. Severe PAS risk factors in large Nordic population study. *BJOG.* 2020;127(11):1465–73.
14. Cali G, Timor-Tritsch IE, Buca D, et al. Diagnostic accuracy of ultrasound for placenta accreta spectrum: updated meta-analysis. *Ultrasound Obstet Gynecol.* 2023;61(6):804–15.
15. Jauniaux E, Jurkovic D. Pathophysiology and imaging anatomy of PAS. *Am J Obstet Gynecol.* 2022;227(3):384–402.

16. Hussein AM, Fox KA, Bhide A, et al. Role of uterovesical hypervascularity in PAS prediction. *BJOG*. 2022;129(1):42–50.
17. Tseng JJ, Hsu SL, Ho ES. Validation of a combined PAS scoring system. *Placenta*. 2020;95:40–6.
18. D’Antonio F, Palacios-Jaraquemada J, Lim PS, et al. Comprehensive review of PAS imaging models. *Am J Obstet Gynecol*. 2020;223(1):1–15.
19. Shamshirsaz AA, Fox KA, Lee W, et al. Maternal morbidity outcomes in PAS with multidisciplinary management. *Am J Obstet Gynecol*. 2021;224(1):51.e1–51.e9.
20. Bailit JL, Grobman WA, Rice MM, et al. Clinical outcomes of PAS in multicenter cohort. *Obstet Gynecol*. 2020;135(4):781–9.