

Prediction of Placenta Accreta Spectrum Disorders in Complete Placenta Previa Complicated with Prior Cesarean

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Purpose: To investigate the predictive value of cervical volume, placental volume, and cervical length for placental accreta (PAS) in patients with complete placenta previa and a history of cesarean section.

Patients and Methods: Three radiologists analyzed MRI images from 157 patients, using 3D Slicer to measure placental volume, cervical volume, and cervical length. The predictive efficacy of combining these three factors for PAS was assessed by plotting Receiver Operating Characteristic (ROC) curves. A scoring system was established, and its predictive accuracy relative to the combined model was evaluated by comparing the Area under Curve (AUC).

Results: Among 157 patients, 72 were diagnosed with PAS. Results showed that increased placental volume and decreased cervical volume and length were significantly associated with PAS occurrence ($P < 0.001$). The combined AUC for predicting PAS was 0.891, with sensitivity of 87.31%, specificity of 83.95%, positive predictive value (PPV) of 82.16%, and negative predictive value (NPV) of 88.65%. The scoring system demonstrated superior predictive performance, with AUC increasing to 0.902, sensitivity at 88.72%, specificity at 84.21%, positive predictive value (PPV) at 82.66%, and negative predictive value (NPV) at 89.82%.

Conclusion: Cervical volume, placental volume, and cervical length are effective indicators for predicting preterm labor. A scoring system developed based on these factors demonstrates higher accuracy.

Keywords: placenta previa, cesarean section, cervical volume, placental volume, cervical length, placenta accreta spectrum disorders

Introduction

Placenta accreta spectrum (PAS) is a serious obstetric complication usually associated with abnormal attachment or invasion of the placenta into the myometrium,¹ which may lead to life-threatening postpartum hemorrhage and hysterectomy.² Indeed, placental implantation spectrum disorders include several types: placental adhesion (anchoring villi attached to the superficial myometrium without insertion into the meconium), placental implantation (infiltration of placental villi into the myometrium), and penetrative placental implantation (anchoring villi tissue penetrating the entire uterine wall and even reaching surrounding organs).³ In recent years, the incidence of PAS has risen significantly with the rising rate of cesarean section and the increasing age of pregnant women.⁴ In order to accurately predict PAS and its associated risks in the prenatal period, researchers have developed various magnetic resonance imaging (MRI)-based prediction models. For example, Maurea et al proposed a model that utilizes ultrasound and MRI features (eg, loss of posterior interstitial space, intra-placental dark bands, and focal interruption of myometrial borders) to predict the risk of PAS in patients with placenta previa.⁵ Andrea et al developed an MRI-based scoring system that, by evaluating indicators such as T2 dark bands, uterine myometrial thinning, and abnormal vascular distribution, has further improving the diagnostic accuracy of PAS.⁶

However, most of these models do not adequately consider the morphological characteristics of the cervix and placenta. In recent years, it has been shown that placental volume and cervical length are closely associated with the

occurrence of PAS and the risk of postpartum hemorrhage. In a study by Yue et al it was found that patients with smaller cervical areas and shorter cervical lengths had significantly more intraoperative hemorrhage and a higher incidence of adverse pregnancy outcomes in the presence of a complete placenta previa.⁷ And a study by Yue et al further confirmed that increased placental volume and T2 dark band volume were positively associated with the risk of major bleeding in patients with PAS.⁸ These findings suggest that morphological characteristics of the placenta and cervix are valuable in risk assessment of PAS.

Based on these studies, this study innovatively combined cervical volume, placental volume, and cervical length to construct a novel PAS risk prediction model. By quantifying these morphological indicators, we aimed to provide clinicians with a more accurate prenatal prediction tool to help them better assess the likelihood of PAS in patients with complete placenta previa who have a history of cesarean delivery. The establishment of this model not only fills the gap of previous studies in cervical and placental morphology, but also provides new ideas for early diagnosis and risk stratification of PAS, which is of great clinical significance.

Materials and Methods

This study was reviewed by the Ethics Committee of Suzhou Hospital of Nanjing Medical University (Approval K-2022-015-K01). Informed consent was waived because this anonymously selected study was retrospective and no new interventions were performed on patients. We reviewed the clinical data of pregnant women with complete placenta previa from January 2018 to August 2024 who had a history of cesarean delivery. Inclusion criteria were: pregnant women with MRI-confirmed diagnosis of complete placenta previa. Exclusion criteria were: (1) twin or multiple pregnancies, (2) no previous history of cesarean section, (3) no pelvic MRI, (4) incomplete clinical or surgical data, and (5) poor image quality affecting observation. The flow chart of the study design is shown in Figure 1. The reason for this design is that MRI is a key tool in the diagnosis of complete placenta previa and placenta implantation spectrum disorders (PAS), providing clearer images than ultrasound and ensuring diagnostic accuracy. By requiring all study subjects to undergo MRI, bias introduced by inconsistent diagnostic tools can be avoided, ensuring homogeneity and reliability of the study data. Ultimately, a total of 157 patients were included in the study, and the diagnosis of PAS was based on the 2019 FIGO criteria.

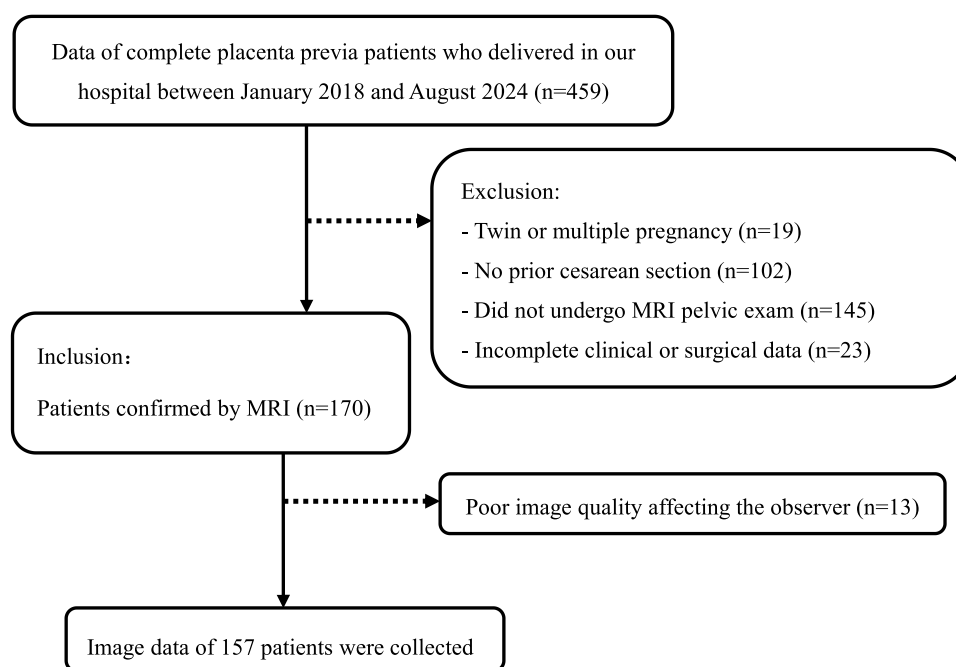


Figure 1 Flow chart of PAS patients with complete placenta previa included in the study.

MRI scans were performed at 3t (Siemens Medical Solutions, Erlangen, Germany) without gadolinium and keeping the bladder partially filled for optimal evaluation of the bladder-plasma membrane interface. Most patients were examined in the supine position, and a few patients who could not tolerate the supine position were examined in the left lateral position. MRI image acquisition employs a T2-weighted half-Fourier single-pass turbo spin-echo sequence to obtain axial, sagittal, and coronal images covering the entire uterus.

Cervical volume, placental volume, and cervical length were measured by three radiologists with over 20 years of experience in obstetric and gynecologic MRI. Radiologists were unaware of all clinical information and other radiologists' impressions. First, MRI images from patients with complete placenta previa were imported into 3D Slicer software (version 5.2.1, www.slicer.org) to create placental and cervical contours and measure placental and cervical volumes with coronal, sagittal, and axial views of the placenta as shown (Figure 2A–C). Subsequently, MRI images from patients with complete placenta previa were imported into ImageJ software version 1.50 (National Institutes of Health, Bethesda, USA) to measure cervical length. The measurement method involved lines a and b passing through the internal and

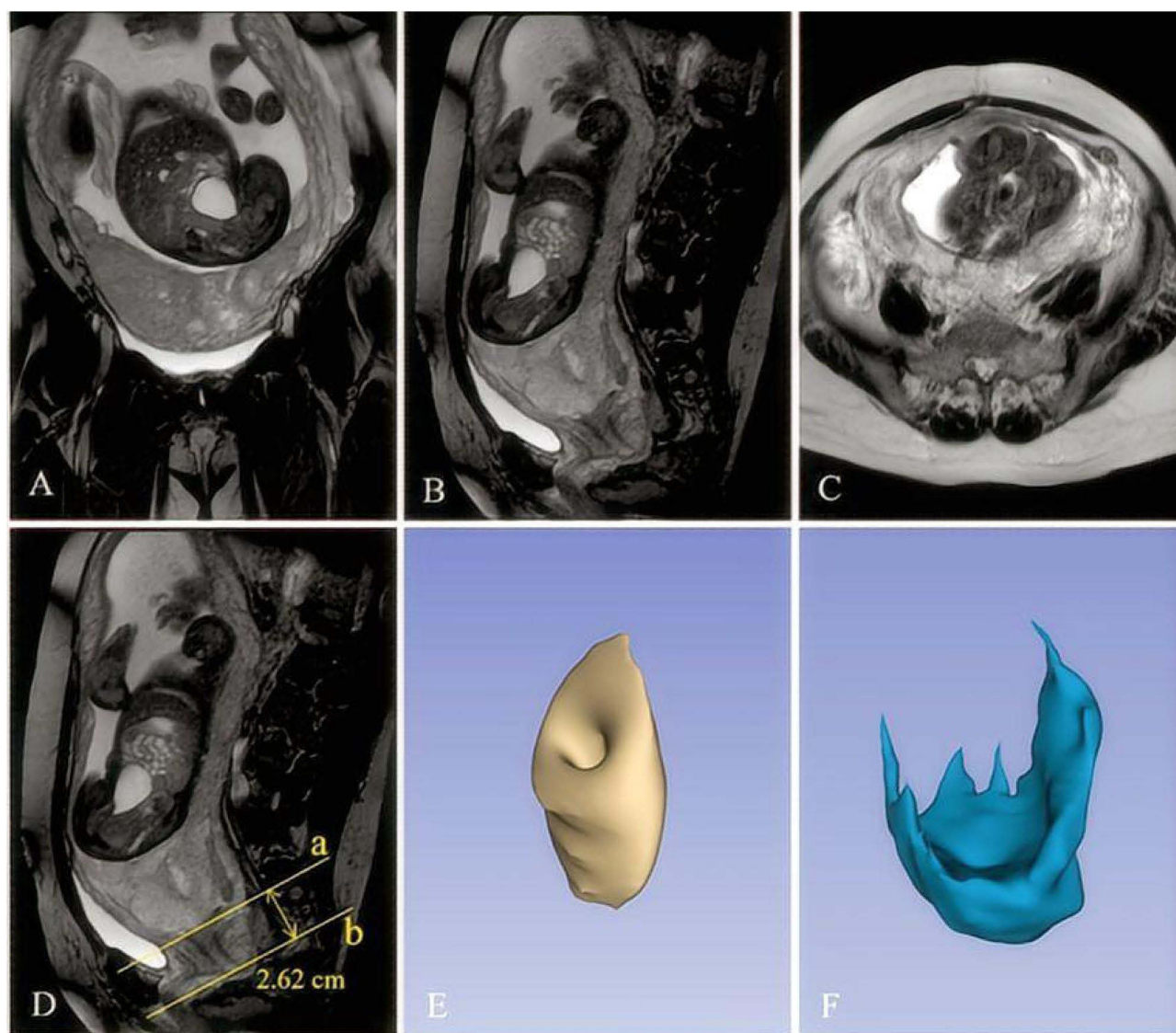


Figure 2 Magnetic resonance imaging (MRI) and three-dimensional (3D) reconstruction of the placenta and cervix in a patient with placenta accreta spectrum (PAS). (A) Coronal T2-weighted MRI view of the placenta. (B) Sagittal T2-weighted MRI view of the placenta. (C) Axial T2-weighted MRI view of the placenta. (D) Measurement of cervical length (2.62 cm) on a sagittal T2-weighted MRI. Line a passes through the internal cervical os, line b passes through the external cervical os, and both are drawn perpendicular to the cervical canal. The double-headed arrow indicates the cervical length, defined as the shortest distance between the two lines. (E) 3D reconstruction model of the cervix, generated using 3D Slicer software. (F) 3D reconstruction model of the placenta, generated using 3D Slicer software.

external cervical canals, respectively, and perpendicular to the cervical canal. The shortest distance between these two lines represented the cervical length (Figure 2D). After segmentation in 3D Slicer software, its 3D reconstruction function generated three-dimensional models of the placenta and cervix. The main steps were as follows: (1) Import the patient's original MRI images in DICOM format; (2) Run the Editor module in the 2D window; (3) Perform segmentation by manually tracing the external contours of the placenta and cervix on each slice; (4) Utilize the program's 3D segmentation function to calculate the volumes of all placental and cervical voxels (Figure 2E and F).

Statistical Analysis

The normality of continuous variables was assessed using the Kolmogorov–Smirnov test. Normally distributed variables were expressed as mean $\pm$ standard deviation, and intergroup comparisons were performed using the independent samples *t*-test. Non-normally distributed variables were expressed as median (interquartile range), and intergroup comparisons were performed using the Mann–Whitney *U*-test. Categorical variables were expressed as case numbers (percentages). Inter-observer agreement in MRI feature assessment was measured using the Kappa coefficient. Pearson correlation analysis explored associations between cervical volume, placental volume, cervical length, and PAS. Receiver operating characteristic (ROC) curve analysis determined optimal cutoff values for MRI features predicting PAS, with corresponding sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) calculated. Sample size estimation was performed using PASS software (version 11.0.7). The current sample size of 157 cases achieves over 90% test power at an $\alpha=0.05$ level. All statistical analyses were conducted using IBM SPSS Statistics software (version 23.0). $P < 0.05$ was considered statistically significant.

Results

In the current study, we performed transabdominal ultrasound and MRI on 157 women who had undergone at least one cesarean section and were confirmed to have complete placenta previa, all of whom had delivered at our healthcare facility. Of these, 72 had placenta accreta (PAS), while the remaining 85 did not. Table 1 details the clinical

Table 1 Clinical Characteristics of Study Participants

Characteristic	Patients with PAS (n=72)	Patients without PAS (n=85)	Statistic (t/Z/ χ^2)	P value
Maternal age	30.906 $\pm$ 4.538	31.830 $\pm$ 4.697	1.247	0.214
BMI (kg/m ²)	25.755 $\pm$ 3.565	26.583 $\pm$ 4.145	1.329	0.186
Gravidity	3 (3,4)	3 (2,4)	1.416	0.157
Parity	2 (1,2)	2 (1,2)	1.254	0.210
Prior dilatation and curettage	2 (1,2)	1 (1,2)	1.580	0.114
History of cesarean delivery	1 (1,2)	1 (1,2)	1.056	0.291
Previous history of placental previa	8 (11.111)	2 (2.353)	5.014	0.025
Gestational age at MRI (weeks)	32.746 $\pm$ 2.547	33.285 $\pm$ 1.954	1.499	0.136
Placental site			7.092	0.008
Previa anterior	45 (62.500)	35 (41.176)		
Previa posterior	27 (37.500)	50 (58.824)		
Antepartum hemorrhage	13 (18.056)	19 (22.353)	0.444	0.505
Gestational age at delivery (weeks)	35.017 $\pm$ 1.873	36.205 $\pm$ 2.128	3.681	< 0.001
Neonatal birth weight (g)	2398.306 $\pm$ 392.851	2697.530 $\pm$ 439.479	4.461	< 0.001

(Continued)

Table 1 (Continued).

Characteristic	Patients with PAS (n=72)	Patients without PAS (n=85)	Statistic (t/Z/ χ^2)	P value
Operation time (min)	103.205 ± 27.481	85.280 ± 31.842	3.740	< 0.001
Intraoperative blood loss (mL)	2530.269 ± 816.426	1106.337 ± 339.506	14.659	< 0.001
Blood transfusion (mL)	1798.135 ± 576.706	619.653 ± 295.759	16.463	< 0.001
Bladder Injury	6 (8.333)	1 (1.176)	4.687	0.030
ICU admission	15 (20.833)	3 (3.529)	11.499	0.001
NICU admission	23 (31.944)	12 (14.118)	7.151	0.007
Hysterectomy	6 (8.333)	1 (1.176)	4.687	0.030
Postoperative hospital stays	6.352 ± 2.976	5.053 ± 2.347	3.056	0.003

Abbreviation: NICU, neonatal intensive care unit.

characteristics of these patients. The mean differences in continuous variables such as age and weight between the two groups were assessed using t-tests. Z-scores were employed to compare the distribution differences of continuous variables between the two groups. For categorical variables (eg, parity, surgical history), the differences in proportions between the two groups were evaluated using chi-square (χ^2) tests. By comparing the general clinical data, we found that maternal age, body mass index (BMI), gestational age, number of deliveries, history of dilatation and curettage, history of cesarean section, gestational age as revealed by MRI, and perioperative hemorrhage did not differ significantly between the two groups ($P > 0.05$). This finding may be related to multiple factors. All patients in the study had a history of cesarean delivery, which means that the two groups were already similar in the baseline characteristic of history of cesarean delivery, and thus the number of cesarean deliveries may no longer be a key factor in distinguishing PAS from non-PAS in this particular population. Second, although the number of cesarean deliveries is an important risk factor for PAS, other factors such as placental volume, cervical volume, and cervical length may have played a more significant role in the development of PAS in this study. In addition, the limitations of the sample size may have led to a statistical failure to detect differences in the number of cesarean deliveries. Therefore, although a history of cesarean delivery is a known risk factor for PAS, other factors may have been more critical in the specific population of this study, resulting in a history of cesarean delivery that was not significantly different between the two groups. In addition, we performed a three-dimensional reconstruction using 3D Slicer software and calculated placental volume, cervical volume, and cervical length. Interobserver variability in MRI images was nearly consistent, with Kappa values for cervical length, cervical volume, and placental volume all exceeding 0.900 (see Table 2). Of particular importance, we found that the placental volume of PAS pregnant women was significantly greater than that of non-PAS pregnant women, while their cervical volume and cervical length were significantly smaller than those of non-PAS pregnant women, and these differences were statistically significant ($P < 0.001$), as detailed in Table 3.

To explore in more depth the risk factors for the development of placental implantation disease (PAS) in patients with complete placenta previa with a history of cesarean delivery, we plotted two subject operating characteristic (ROC)

Table 2 Interobserver Reliability of Magnetic Resonance Imaging (MRI) in the Measurement of MRI Features

MRI Feature	Either	All	Agree	Kappa
Cervical length	72	65	95.641%	0.9201
Cervical volume	76	70	96.178%	0.9106
Placental volume	75	68	95.541%	0.9412

Table 3 MRI Signs Related to PAS in Caesarean Section

	Patients with PAS (n=72)	Patients without PAS (n=85)	Statistic (t)	P value
Placental volume (cm ³)	1053.639 ± 353.305	765.382 ± 212.842	6.295	< 0.001
Cervical volume (cm ³)	15.036 ± 4.872	26.083 ± 5.392	13.366	< 0.001
Cervical length (cm)	1.873 ± 0.489	2.705 ± 0.536	10.086	< 0.001

curves (Figure 3). In this case, the dashed line demonstrates the role of three indicators, placental volume, cervical volume, and cervical length, in predicting the occurrence of PAS. From the ROC curve analysis, we identified optimal threshold values for placental volume (880.0 cm³), cervical volume (20.0 cm³), and cervical length (3.0 cm) (Figure 4), which are important for distinguishing between pregnant women who are likely to develop PAS and those who are unlikely to do so. Subsequently, we created a novel predictive model based on these thresholds. The model was designed to explore the complex relationship between cervical volume, placental volume, and cervical length and the likelihood of PAS in pregnancies with complete placenta previa with a history of cesarean delivery. To assess this relationship more visually, we further developed a scoring system (shown in Table 4). The design of the scoring system was based on the Odds Ratio (OR) value of each indicator, ie, their independent predictive value for the occurrence of PAS. The OR for cervical volume was 4.132, for cervical length was 2.875, and for placental volume was 2.076. These ORs reflect the strength of the association between each indicator and the occurrence of PAS, with a higher OR indicating a stronger prediction of PAS by that indicator. Thus, cervical volume was assigned a score of 2, while cervical length and placental volume had relatively low OR values and were assigned a score of 1 each. Based on the scores, patients were categorized into low-risk (0–1), intermediate-risk (2) and high-risk (3–4) groups, with 76 cases in the low-risk group and 13 cases (17.1%) with combined PAS disease, 33 cases in the intermediate-risk group with combined PAS (21 cases (63.6%)) and 47 cases in the high-risk group with combined PAS (38 cases (80.9%)), which shows that with the increase in the scores, the incidence of the probability of PAS disease increases (Figure 5). In order to verify the accuracy of the scoring system, we again plotted a ROC curve (solid line). This curve demonstrates the predictive effect of the score after scoring assignment on the occurrence of PAS in those with complete placenta previa with a history of cesarean delivery. The

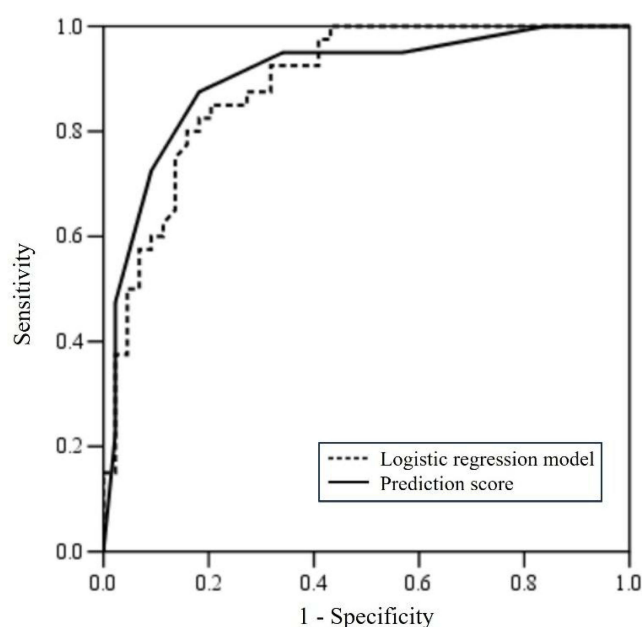


Figure 3 Receiver operator characteristic curves for the regression model with cervical length, cervical volume, and placental volume, and for prediction score. Dashed line AUC= 0.891. solid line AUC= 0.902.

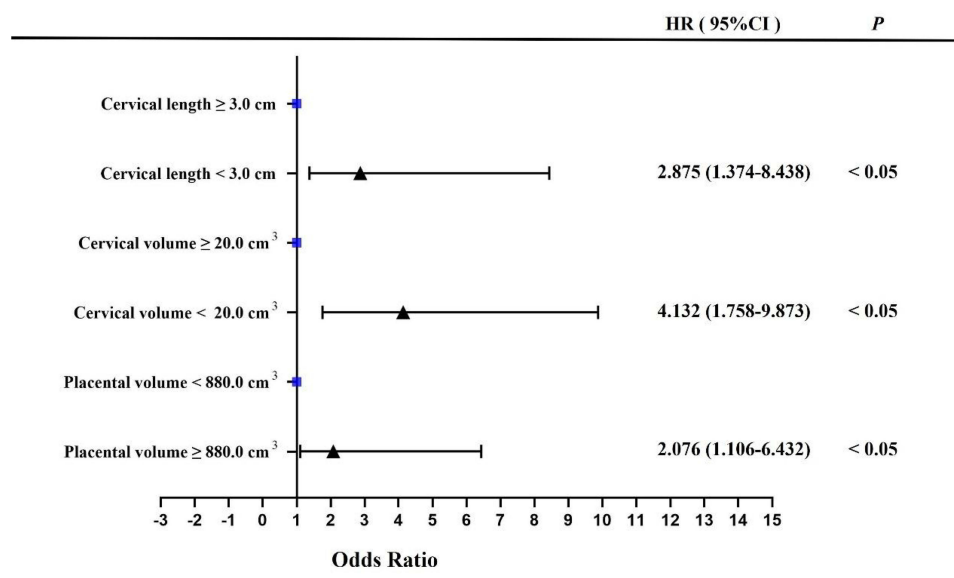


Figure 4 Multivariate logistic regression analysis of risk factors for patients with PAS.

results showed that the AUC value of the dashed line (raw index) was 0.891, while the AUC value of the solid line (scoring system) was 0.902. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for predicting PAS based on individual signs are shown in Table 5. When combined with cervical length, cervical volume, and placental volume, the sensitivity, specificity, PPV, and NPV for predicting PAS were 87.305%, 83.946%, 82.163%, and 88.645%, respectively. When applying the scoring system to predict PAS, the sensitivity, specificity, PPV, and NPV were 88.723%, 84.209%, 82.663%, and 89.817%, respectively. The high agreement between the two curves indicates that the scoring system we developed has a high accuracy in predicting the occurrence of PAS. This provides a powerful tool for assessing the risk of PAS in patients with complete placenta previa who have a history of cesarean delivery.

Discussion

Previous studies have shown that the risk of placenta previa (PP) is usually associated with previous cesarean section, increases with the number of previous CS, and is an independent risk factor for PAS.⁹ In addition, PP combined with scarred uterus significantly increases the risk of developing PAS.^{10,11} Therefore it is crucial to accurately predict the likelihood of PAS in women with placenta previa with a history of cesarean section in the antenatal period, which enables adequate preoperative preparation, for example, by planning the delivery in a referral labor ward, where more necessary means (blood transfusion, interventional radiology, resuscitation and surgical skills, etc.) are available.¹² When women with PAS deliver in a tertiary referral center with an experienced multidisciplinary team, maternal mortality and complication rates associated with PAS are significantly reduced.^{13–16}

Table 4 PAS Index in Complete Placenta Previa with Prior Cesarean (PIPs)

	Score
Cervical length	1
Cervical volume	2
Placental volume	1

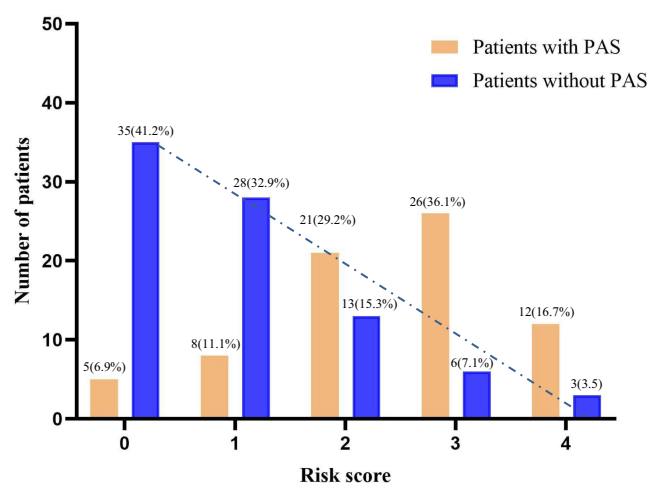


Figure 5 Simple scoring model evaluated for correspondence with PAS.

In recent years, several researchers have also created different ultrasound scoring systems to help clinicians effectively predict PAS and adverse clinical outcomes before delivery. Zou¹⁷ et al scored the number of previous cesarean deliveries, placental position, placental/uterine augmentation, placental heterogeneity, placental T2 dark bands, intra-placental vascular anomalies, placental bed vascular anomalies, loss of the T2 low-signal interface, interruption of the bladder wall, penetrating PI and muscle thinning and interruption to investigate whether magnetic resonance imaging can effectively predict the diagnosis of malignant placenta previa with or without PAS and adverse clinical outcomes. In addition, Tovbin¹⁸ created a new ultrasound scoring system that scored the number and size of placental sockets; occlusion of the boundary between the uterus and the placenta; placental position; color Doppler signals within the placental sockets; vascular richness of the placenta-bladder and/or utero-placental interface area; and number of previous cesarean deliveries. It was found that all ultrasound criteria of the scoring system were significantly associated with pathologically adherent placenta (MAP) ($P < 0.001$). This provides additional and stronger imaging evidence for the diagnosis of MAP. Correct prenatal diagnosis buys more time for the multidisciplinary team to plan the delivery, which will help to reduce surgical complications, maternal blood loss, and length of stay in the intensive care unit.^{14,19,20}

In contrast to previous studies, the scoring system created in this study incorporated cervical morphology, and we chose placental volume, cervical volume, and length as key predictors of PAS based primarily on their pathophysiologic relevance. Increased placental volume usually reflects hyperplasia of placental tissue, especially in pregnant women with a history of cesarean section, where damage to the endometrium and myometrium may lead to abnormal invasion of placental villi into the myometrium, which may in turn increase the risk of PAS. Yue et al showed that the of PAS in patients with a placental volume greater than 887 cm³ was 85.531%, and the specificity was 83.907%, which indicating that placental volume is an important predictor of PAS.²¹ Shorter cervical length and volume were negatively associated with the severity of PAS and the risk of hemorrhage. Shorter cervical length usually means that the placenta may have invaded the cervical region, leading to disruption of cervical structures and abnormal vascular distribution. Yue et al found that patients with cervical length less than 30 mm had a significantly increased risk of hemorrhage, and cervical length was negatively correlated with hemorrhage volume.⁷ Based on these studies, this study innovatively combined cervical volume, placental volume and cervical length to construct a new PAS risk prediction model.

Table 5 Receiver Operating Characteristic Analysis for Prediction of PAS Based on Cervical Volume, Cervical Length, and Placental Volume

Variable	Sensitivity%	Specificity	PPV	NVP
Logistic regression model	87.305%	83.946%	82.163%	88.645%
Prediction score	88.723%	84.209%	82.663%	89.817%

Notably, the results of this study indicate that the proportion of anterior placenta was significantly higher in the PAS group than in the non-PAS group (62.5% vs 41.2%, $P = 0.008$). This difference may be related to the fact that uterine scars after cesarean section are often located on the anterior wall, making the placenta more likely to attach to this area. Despite differences in placental location distribution between groups, this model's advantage lies in its independence from placental location as a single variable. Instead, it achieves precise disease risk assessment by directly capturing PAS-induced morphological end changes in the cervix and placenta—such as reduced cervical volume and increased placental volume. Consequently, this model demonstrates greater universality. Regardless of whether the placenta is located in the anterior or posterior wall, characteristic morphological alterations can be effectively identified, achieving high predictive performance ($AUC = 0.902$).

The International Society for Abnormal Invasive Placenta (IS-AIP) has proposed several criteria for MRI signs of PAS, including Focal exophytic mass, Myometrial thinning, Bladder wall interruption, Abnormal vascularization of the placental bed, etc.¹² These MRI signs suggested by IS-AIP are high risk signals for PAS. In contrast, the present study identified PAS by measuring placental volume, cervical volume, and cervical length, which provides new MRI signs for prenatal prediction of PAS. It is noteworthy that the scoring system achieves quantitative evaluation by assigning corresponding points to each parameter: cervical length (CL) < 3.0 cm receives 1 point, cervical volume (CV) < 20.0 cm³ receives 2 points, and placental volume ≥ 880.0 cm³ receives 1 point. Thus, pregnant women meeting all these criteria achieve the maximum score of 4 points. Based on this scoring, patients with 3–4 points belong to the high-risk group for PAS disease. For example, PA patients with a history of CS who have CL < 3.0, CV < 20.0, and PV ≥ 880.0 strongly suggest concomitant PAS disease. This approach reduces diagnostic subjectivity to some extent. Thus, this scoring system offers clinicians a novel approach for prenatal assessment of PAS occurrence probability.

Furthermore, numerous previous studies have demonstrated associations between molecular biomarkers such as Cripto-1, AFP, and PAPP-A with PAS and placenta previa. Serum Cripto-1 levels in patients with PAS were significantly higher than in those with PP but without pregnancy complications. Elevated AFP levels during mid-pregnancy independently predicted PAS requiring hysterectomy, while elevated PAPP-A correlated with PAS and postpartum hemorrhage volume. In the future, integrating biomarkers like Cripto-1, AFP, and PAPP-A with imaging morphological parameters into predictive models may further enhance the comprehensiveness and accuracy of PAS prediction.

This study has several limitations. First, its retrospective design carries a risk of selection bias, and the limited sample size prevented complete matching between the PAS and non-PAS groups. Second, discrepancies between specimen collection times and disease diagnosis times in some laboratories may have affected the accuracy of certain indicators. Third, while inter-observer agreement was assessed and demonstrated good reproducibility ($Kappa > 0.9$), intra-observer variability was not analyzed. Although all measurements were performed by uniformly trained radiologists, future studies may incorporate automated segmentation techniques to further enhance measurement efficiency and objectivity. Finally, placental position, as a potential confounding factor, requires further clarification regarding its independent contribution to PAS occurrence alongside cervical-placental morphological parameters. Subsequent prospective studies with larger samples should employ multivariate or stratified analyses to determine the independent predictive value of each parameter, thereby optimizing model structure and diagnostic performance.

Conclusions

Cervical length, cervical volume and placental volume are independent risk factors for having PAS disease in patients with complete placenta previa with a history of cesarean delivery. According to the scoring system in this study, the higher the score, the higher the risk of having PAS disease in patients with complete placenta previa with a history of cesarean delivery. This scoring system has the potential to be applied to predict the likelihood of having PAS in patients with complete placenta previa with a history of cesarean delivery, thus contributing to the prenatal selection of rational treatment.

Abbreviations

PAS, placental implantation spectrum; MRI, magnetic resonance imaging; FIGO, International Federation of Gynecology and Obstetrics; DICOM, digital imaging and communications in medicine; PPV, positive predictive value; NPV, negative predictive value; ROC, receiver operating characteristic; BMI, body mass index; NICU, neonatal intensive care unit; OR,

odds ratio; PP, placenta previa; CS, caesarean section; MAP, morbidly adherent placenta; IS-AIP, International Society for Abnormal Invasive Placenta; CL, cervical length; CV, cervical volume; PV, placental volume; PA, placenta accreta.

Data Sharing Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This study was reviewed by the Ethics Committee of Suzhou Hospital of Nanjing Medical University (Approval K-2022-015-K01). Informed consent was waived because this anonymously selected study was retrospective and no new interventions were performed on patients.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no competing interests in this work.

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