The Egyptian Journal of Hospital Medicine (October 2025) Vol. 101, Page 5440-5449

Validity of a Recent Ultrasonographic Staging System for Placenta Accreta Spectrum Disorders

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ABSTRACT

Background: The placenta accreta spectrum (PAS) is a spectrum of placental attachments, with an incidence ranging from 1/533 to 1/731 deliveries and a maternal death rate reaching 7%. Moreover, repeated CS is considered the most significant risk factor.

Objective: the present study, we aimed to validate the **Cali *et al.*** scoring system for predicting the PAS.

Methodology: A prospective observational study that was conducted at The Ultrasound Unit and Maternity Hospital in The Obstetrics and Gynecology Department, Zagazig University through the period from January 2020 to May 2023 where fifty-seven patients were included. Every patient was subjected to a Cali ultrasonographic scoring system to predict placental invasion and to the FIGO clinical grading system during delivery. Furthermore, histopathological examination was performed for patients who underwent hysterectomy.

Results: PAS 3 could predict the presence of placenta percreta with an area under the curve of 0.625, a sensitivity of 75%, a specificity of 50%, a positive predictive value of 60%, a negative predictive value of 66.7%, and an overall accuracy of 62.5% (p=0.487).

Conclusion: After validation of the Cali et al. scoring system in our study, the prediction of placental invasion was lower than that reported by Cali et al. in their research. Moreover, the performance of the Cali et al. scoring system was not better than that of other scoring systems in the prediction of placental invasion in PAS patients.

Keywords: Placenta previa, Cesarean section, Cali et al. scoring, Adherent placenta.

INTRODUCTION

The placenta accreta spectrum (PAS) is a spectrum of placental attachment disorders, including trophoblastic invasion of the myometrium in the absence of intervening decidua. Myometrial invasion is classified as accreta, increta, or percreta according to the degree of myometrial invasion, whether superficial, deep, or extended through the serosa into adjacent pelvic organs, respectively [(1)]. The incidence of placenta accreta ranges from 1/533 to 1/731 deliveries, from which the maternal death rate may reach 7% [(2)].

In the last five decades, the incidence has increased tenfold. Unfortunately, it is still rising owing to increasing rates of Cesarean section (CS), assisted reproductive technology and high maternal age [(3)].

In Egypt, the CS rate is 56% and increasing for various reasons, such as fear of pain, genital damage that may occur during vaginal delivery, intolerance of complications, and the common misconception that CS is better for the mother and fetus [(4)]. PAS is currently the most common reason for emergency peripartum hysterectomy and is linked to high rates of massive bleeding as well as the need for blood transfusion, renal failure, respiratory failure and intensive care unit (ICU) admission [(5)]. The increasing rates of Cesarean section and history of placenta previa and accreta in a previous pregnancy are considered the most significant risk factors for the development of PAS in subsequent pregnancies. Uterine congenital anomalies, myometrial pathologies, and uterine surgeries such as endometrial curettage, manual placental delivery, and some hysteroscopic surgeries may function as risk factors. Still, they represent a tiny minority compared with repeated CS. On the other hand, PAS has still been observed in females without a history of uterine surgery, even in primigravida [(6)].

The antenatal diagnosis of PAS permits the availability of a multidisciplinary team approach that decreases maternal and fetal morbidities and mortalities during delivery [(7, 8)]. An antenatal diagnosis of PAS can be achieved via ultrasound and/or MR imaging. Both methods have comparable diagnostic accuracy because they rely on observer experience, with increasing sensitivity and specificity owing to increased expertise and equipment advancements [(9)].

MRI is indicated only in cases of unobvious diagnosis, posterior placentation, and suspected parametrial extension for a more precise distinction of the depth of placental invasion [(10)]. However, ultrasound is considered the first-line method for diagnosing antepartum placental abnormalities, with high sensitivity and specificity rates reaching 85.7% and 88.6% respectively [(11)]. There is no published consensus on the definition of ultrasound markers for the diagnosis of PAS. The 'European Working Group on Abnormally Invasive Placenta' also proposed standardized ultrasound descriptors of the abnormally invasive placenta [(12)]. Most of these descriptors were assessed in a recent systematic

Received: 01/06/2025
Accepted: 03/08/2025

review and meta-analysis. The authors concluded that myometrial thinning, bladder wall interruption, and ureterovesical hypervascularity were linked to the most severe types (placenta percreta) [10].

Many studies have suggested ultrasound-based scoring models for the prediction of PAS. The main purpose of these models was to decrease subjectivity and the subsequent waste of medical resources and increase the risk of complications because of unneeded operative interference attributed to overdiagnosis. However, these models do not differentiate the variable types of PAS involving the most severe types of placental invasion (placenta percreta) [13, 14, 15, 16]. Although several prediction models for the PAS have been developed, the percentage of external validation studies is small. Therefore, in the present study, we aimed to validate the **Cali *et al.*[13]** scoring system for predicting the PAS.

METHODS

This prospective observational study was conducted at Ultrasound Unit and Maternity Hospital, The Obstetrics and Gynecology Department, Zagazig University, from January 2020 to May 2023. This research included fifty-seven expectant mothers who had ultrasound-diagnosed placenta previa or a low-lying placenta and were admitted to the maternity hospital at Zagazig University.

All patients were counseled about different management options and informed written consent was signed by the patients, who discussed the different management options and possible fetal and maternal complications and sequelae. Every patient was subjected to careful medical history and clinical examination. Preoperative laboratory investigations were performed to assess the patient's overall performance.

Ultrasound and color Doppler examination: Using transabdominal (TAUS) and transvaginal ultrasonography (TVUS) with a GE 2D Voluson 730 pro mounted by a transabdominal probe (3-5 MHZ convex array sector transducer) and transvaginal probe (RIC5-9H) and a Mindray Nuewa I9 mounted by a curved transabdominal transducer (SC6-1 s up to 6 MHZ) and transvaginal transducer (V11-3Hs), both single-crystal.

A- Routine ultrasound: fetal biometry, amniotic fluid, and placental location.

B- Cali *et al.*[13] scoring system for the diagnosis of PAS was applied to the basis of the following ultrasound signs [17]:

(1) ***Loss of the clear zone***, defined as loss or irregularity of the hypoechoic plane in the myometrium underneath the placental bed. (yellow arrows) (Figure 1).

(2) ***Placental lacunae***, defined as the presence of numerous lacunae, often contain turbulent flow visible on grayscale or color Doppler ultrasound (Figure 2).

(3) ***Bladder wall interruption***, defined as loss or interruption of the bright bladder wall (hyperechoic band or 'line' between the uterine serosa and bladder lumen) Figure 3).

(4) ***Uterovesical hypervascularity***, defined as a striking amount of color Doppler signal observed between the myometrium and the posterior wall of the bladder including vessels that appear to extend from the placenta, across the myometrium, and beyond the serosa, into the bladder or other organs, often running perpendicular to the myometrium (Figure 4).

(5) ***Increased vascularity in the parametrial region***, defined as hypervascularity extending beyond the lateral uterine walls and involving the region of the parametria (Figure 5).

- All cases were classified according to the **Cali *et al.*[13]**. Scoring system for PAS as follows:
- ***PAS 0*:** Placenta previa with no signs of invasion or placenta previa with placental lacunae but no evidence of an abnormal uterus–bladder interface (i.e., no loss of the clear zone and/or bladder wall interruption).
- ***PAS 1*:** The presence of at least two lesions: placental lacunae, loss of the clear zone and bladder wall interruption.
- ***PAS 2*:** PAS1 plus uterovesical hypervascularity.
- ***PAS 3*:** PAS1 or PAS2 plus evidence of increased vascularity in the inferior part of the lower uterine segment extending into the parametrial region**.**

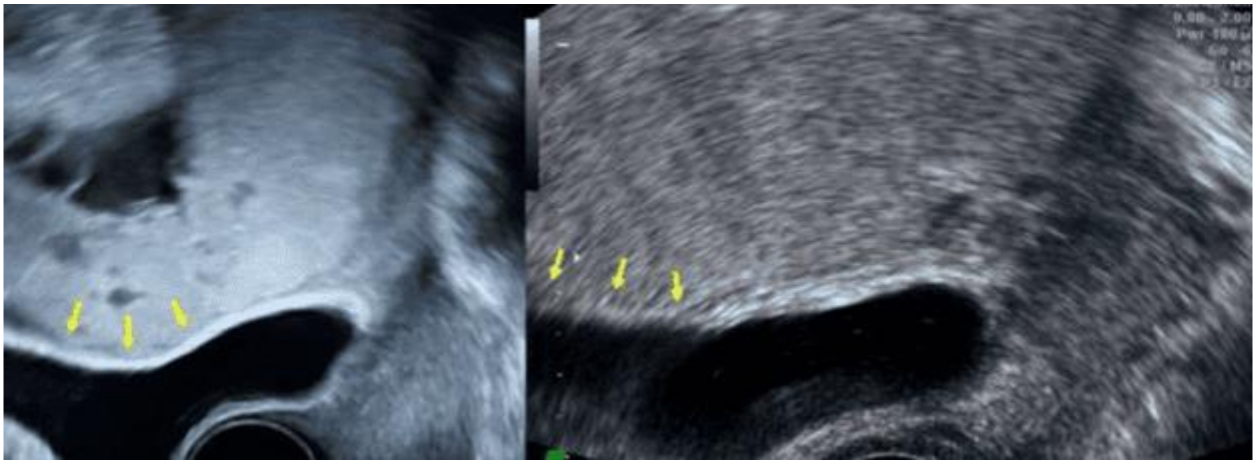


Figure (1): Loss of the clear zone, defined as loss or irregularity of the hypoechoic plane in the myometrium underneath the placental bed (Yellow arrows).

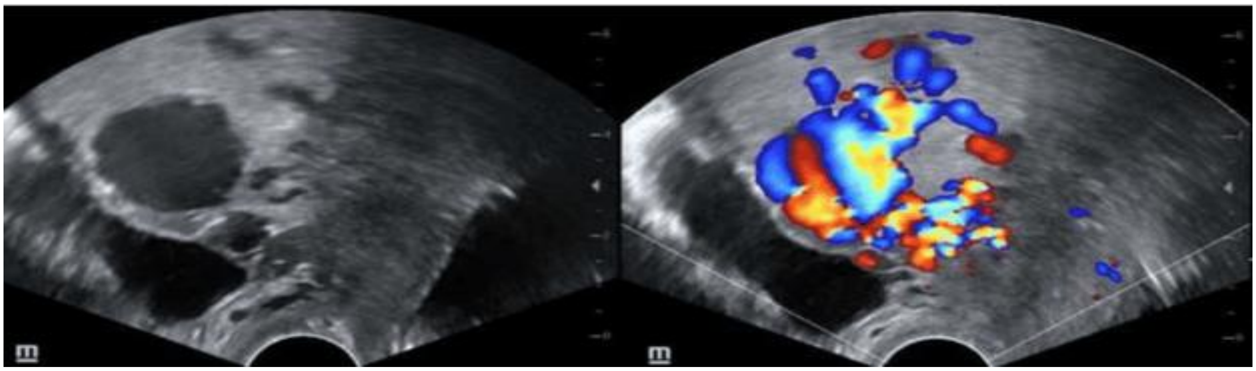


Figure (2): Placental lacunae, defined as the presence of numerous lacunae, often containing turbulent flow visible on grayscale or color Doppler ultrasound.

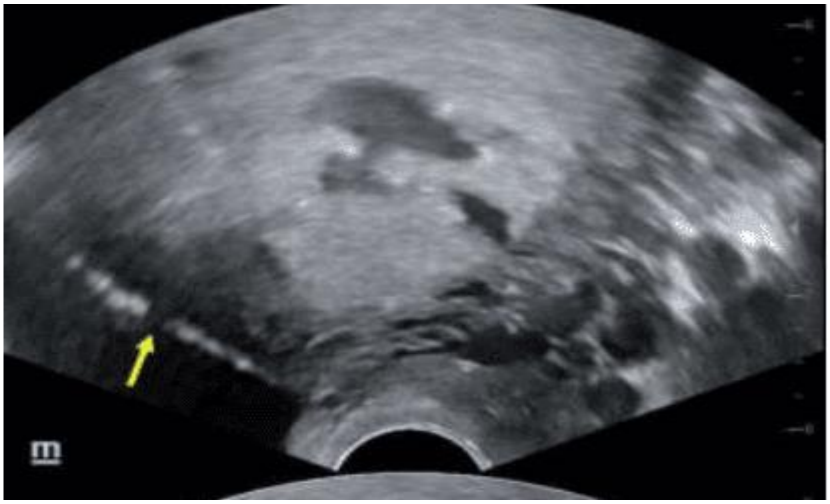


Figure (3): Bladder wall interruption, defined as loss or interruption of the bright bladder wall (hyperechoic band or 'line' between the uterine serosa and bladder lumen).

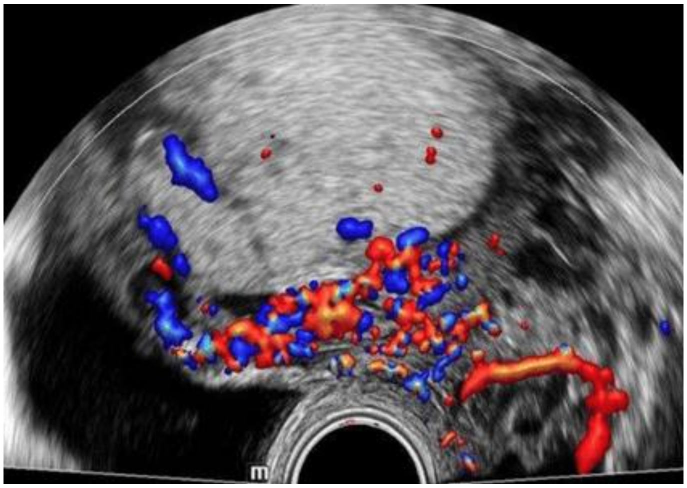


Figure (4): Uterovesical hypervascularity, defined as a striking amount of color Doppler signal seen between the myometrium and the posterior wall of the bladder including vessels appearing to extend from the placenta, across the myometrium, and beyond the serosa, into the bladder or other organs, often running perpendicular to the myometrium.

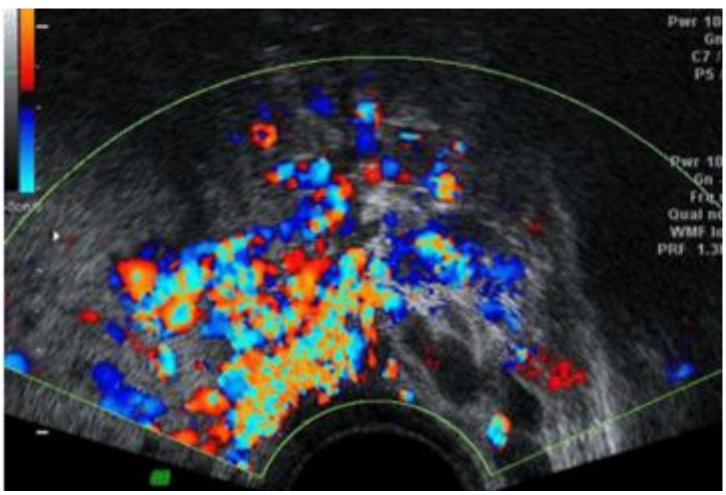


Figure (5): Increased vascularity in the parametrial region, defined as the presence of hypervascularity extending beyond the lateral uterine walls and involving the region of the parametria.

C- FIGO clinical grading system for PAS disorders was applied at delivery. According to this clinical staging system, PAS disorders can be categorized into subgroups as follows:

***Grade 1*:** At Cesarean or vaginal delivery, there was complete placental separation at the third stage and normal adherence of the placenta.

***Grade 2*:** At the Cesarean section/laparotomy, no placental tissue was observed invading through the surface of the uterus. There was incomplete separation with uterotonics and gentle cord traction, manual removal of the placenta is required for remaining tissue, and parts of the placenta were thought to be abnormally adherent. At vaginal delivery, manual removal of the placenta was needed, and parts of the placenta were thought to be abnormally adherent (Figure 6).

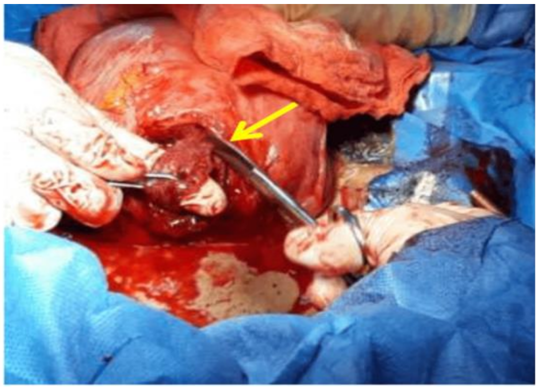
Grade 3: At Cesarean section/laparotomy, no placental tissue was observed invading through the surface of the uterus. There was no separation with uterotonics or gentle cord traction, manual removal of the placenta is needed, and the whole placental bed was thought to be abnormally adherent. At vaginal delivery, manual removal of the placenta was needed, and the whole placental bed was thought to be abnormally adherent (Figure 7).

***Grade 4*:** At Cesarean section/laparotomy, placental tissue was seen to have invaded through the serosa of the uterus, but a clear surgical plane can be identified between the bladder and uterus to allow nontraumatic reflection of the urinary bladder at surgery (Figure 8).

***Grade 5*:** At Cesarean section/laparotomy, placental tissue had invaded through the serosa of the uterus, and a clear surgical plane cannot be identified between the bladder and uterus to allow nontraumatic reflection of the urinary bladder at surgery (Figure 9).

***Grade 6*:** At Cesarean section/laparotomy, placental tissue was seen to have invaded through the serosa of the uterus and be infiltrating the parametrium or any organ other than the urinary bladder [18].

The surgical outcome was also assessed by the amount of blood product transfusion, operation time (hours), surgical complications, length of hospital stay (days), and admission to the ICU.



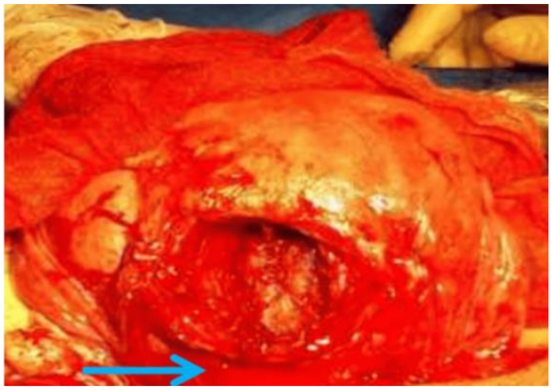


Figure (6): FIGO grade 2: The left figure showed that part of the placenta is adherent to themyometrium (yellow arrow) and the right figure showed that the placenta did not invade the serosa of the uterus (blue arrow).

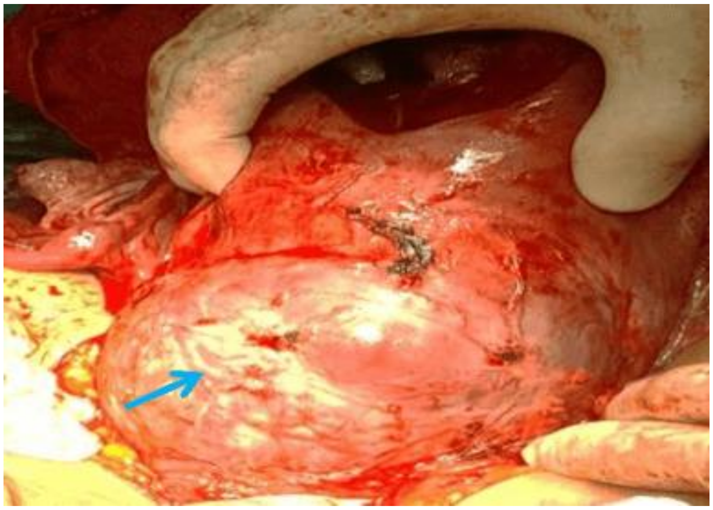
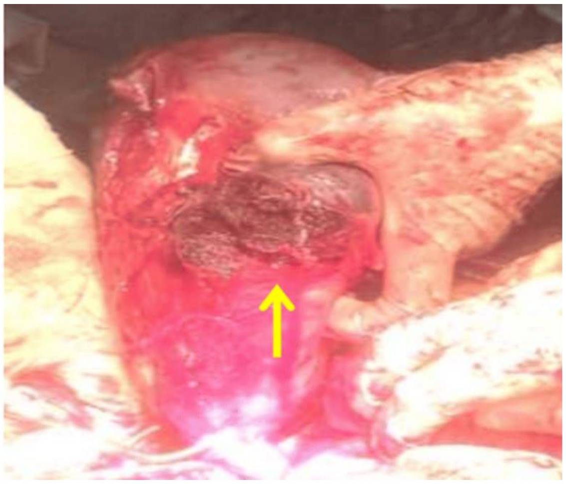


Figure (7): FIGO grade 3: The whole placenta was adherent to the myometrium (needed manual separation) with excessive vascularity in the lower uterine segment and the placenta did not invade the serosa of the uterus (blue arrow).



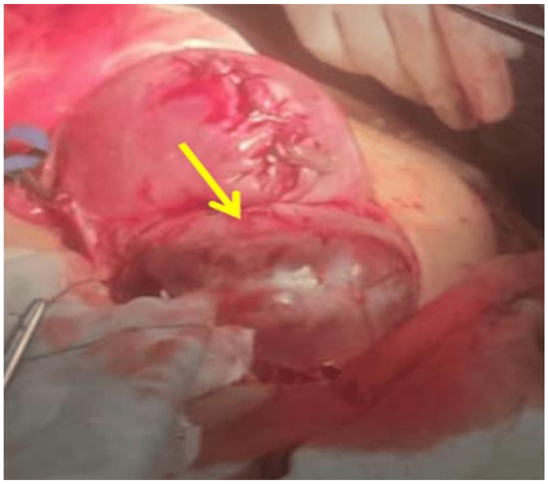


Figure (8): FIGO grade 4: Both figures showed that the placenta invaded the serosa of the uterus but with a clear surgical plane between the bladder and the uterus (yellow arrows).

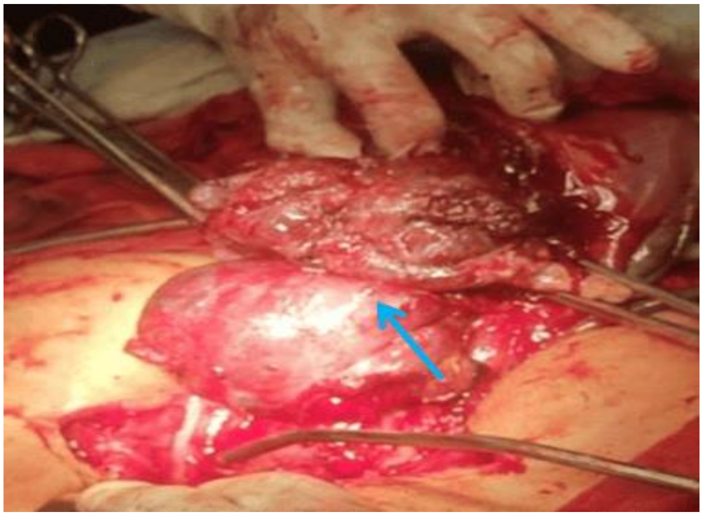


Figure (9): ***Grade 5***: At Cesarean section/laparotomy, placental tissue was seen to have invaded through the serosa of the uterus, and a clear surgical plane cannot be identified between the bladder and uterus to allow non-traumatic reflection of the urinary bladder at surgery.

D- Histopathological examination (HPE) of hysterectomy samples *(in patients who underwent CS hysterectomy):*

Macroscopic examination: For gross placental invasion and disruption of the uterine wall (e.g., thinning of the myometrium opposite the placenta, extent, and percentage of wall invasion or extrauterine structure invasion) [(6)].

Microscopic examination: Histopathologic examination of blocks from the umbilical cord, chorionic membranes, and full-thickness blocks of the placental parenchyma with the uterine wall and additional blocks, depending on the macroscopic findings, was performed. After that, all the slides were subjected to routine hematoxylin and eosin (H & E) staining.

Pathological findings were classified according to *placental invasion depth* as follows:

1- *Placenta accreta*: Anchoring placental villi attached to the myometrium rather than the decidua without completely invading it.
2- *Placenta increta:* Diagnosed when chorionic villi invade the myometrium.
3- *Placenta percreta*: Diagnosed if chorionic villi invaded through the myometrium into the serosa of the uterus or nearby organ. The outcomes of this study were maternal and fetal morbidity and mortality rates.

Ethics approval and consent to participate: The study was approved by The Institutional Research Review Board of Zagazig Faculty of Medicine (IRB) under reference number (ZU-IRB# 5848-29-12-2019) and by Zagazig Hospitals Administration. Informed consents to participate in the study was taken from all the participants after explaining the study objectives, measures and assuring confidentiality. All experiments were performed in accordance with relevant guidelines and regulations and participants were not exposed to any harm or unintended effect. The study followed the ethical principles of the Declaration of Helsinki.

Statistical analysis

Data analysis was performed via the software SPSS (Statistical Package for the Social Sciences) version 26. Categorical variables were presented as absolute frequencies and were compared via the Chi-square test and Monte Carlo test when appropriate. The Shapiro–Wilk test was used to verify the assumptions for use in the parametric tests. Quantitative variables were described as means and standard deviations or medians and interquartile ranges according to the type of data. To assess the strength and direction of correlation between two continuous variables, Spearman rank correlation coefficients (for nonnormally distributed data) were used. To compare quantitative data between two groups, the Kruskal-Walli's test (for nonnormally distributed data) and one-way ANOVA (for normally distributed data) were used. When the difference was significant, pairwise comparisons and Fisher's least significant difference (LSD) tests were used to detect differences between two individual groups. The ROC curve was used to determine the best cutoff of certain quantitative parameters in the diagnosis of certain health problems. The reliability and agreement between the two methods for assessing the same parameters were assessed via interclass correlation and Cronbach's alpha. The level of statistical significance was set at $P \leq 0.05$. A highly significant difference was present if p was ≤ 0.001.

RESULTS

Fifty-nine patients were subjected to the Cali PAS scoring system. Two of the fifty-nine patients were excluded from the study because of social factors. Therefore, fifty-seven patients were enrolled in the study. The mean age of these patients was 30.56 ± 5.26 years, while the mean gestational age at the time of termination was 37.01 ± 1.97 years. The parity ranged from 0-4 (Table 1).

Table (1): patient characteristics among the studied group

Variable	Studied group (n= 57)
Maternal age *Mean ± SD*	30.56 ± 5.26
Fetal age at delivery *Mean ± SD*	37.01± 1.97
Parity *(median- range)*	2 (0-4)
Positive medical history N (%)	6 (10.5%)
Positive surgical history N (%)	48 (84.2%)

Data presented as Mean ± SD, median (range), n (%)

Antenatal ultrasound via TAUS and/or TVUS confirmed that half of the cases (49.1%) were classified as PAS 3, 19.3% as PAS 2, 14% as PAS 1, and 17.5% as PAS 0. The FIGO classification was utilized during surgery for all patients (Table 2).

Table (2): Distribution of the studied patients according to ultrasonographic data (Cali PAS scoring system) and FIGO classification

PAS	N=57	%
0	10	17.5%
1	8	14%
2	11	19.3%
3	28	49.1%
FIGO	**N =57**	**%**
Grade 1	6	10.5%
Grade 2	15	26.3%
Grade 3	13	22.8%
Grade 4	16	28.1%
Grade 5	7	12.3%

***Data presented as n* (%) .**

Intraoperative results revealed that the placenta was separated spontaneously or by manual separation in thirty-seven patients; two patients underwent a second set of CS hysterectomies. In contrast, the placenta could not be separated in eighteen patients, upon which a CS hysterectomy was performed, while uterine wall excision and reconstruction could be achieved in two patients.

According to the HPE data, half of the cases were accreta, whereas increta and percreta were presented equally in the other half. Most babies had good outcomes, and only 7% of them needed NICU admission. There was a statistically significant positive correlation between the PAS score and patient age, parity, number of previous CSs, number of packed RBCs, and fresh frozen plasma administration. Additionally, there was a highly significant positive correlation between the PAS score and both the operative time, and the length of hospital stay (Table 3).

Table (3): Correlation between PAS score and the studied parameters

	R	P
Age (year)	0.338	0.01*
Parity	0.329	0.013*
Number of previous CS	0.272	0.041*
Gestational age (week)	0.033	0.809
Operative time	0.523	<0.001**
Packed RBCs	0.419	0.002*
Fresh frozen plasma	0.450	0.002*
Length of hospital stay	0.422	<0.001**

R: Spearman rank correlation coefficient, *p <0.05 is statistically significant, **p ≤0.001 is statistically highly significant.

Moreover, the PAS and FIGO grading systems showed significant agreement *(Cronbach's alpha 0.852)*, and there was good reliability for each system *(ICC=0.852).*

Table (4) All hysterectomy samples were PAS 2 or 3 on HPE. However, the relationship between thePAS stage and the degree of placental invasion was not statistically significant.

Table (4): Agreement between PAS score and FIGO staging

	R	ICC (95% CI)	Cronbach alpha	P
PAS	0.721	0.852 (0.75 – 0.913)	0.852	<0.001**

Cronbach α (0.8 - <0.9) means good agreement, ICC between 0.75 and 0.9 good reliability, r : Spearman rank correlation coefficient, **p≤0.001 is statistically highly significant.

The PAS 3 score can be used to diagnose the presence of placenta increta and percreta in eight out of twelve patients. The PAS 3 score can predict the presence of both placenta increta and percreta with a sensitivity of 66.7%, specificity of 50%, positive predictive value of 80%, negative predictive value of 33.3%, and overall accuracy of 62.5% (Table 5).

Table (5) Performance of PAS scoring system in prediction of placenta percreta

Cutoff	AUC	Sensitivity	Specificity	PPV	NPV	Overall accuracy	P
≥3	0.625	75%	50%	60%	66.7%	62.5%	0.401

AUC: area under curve PPV: positive predictive value NPV: negative predictive value.

DISCUSSION

Placenta accreta spectrum (PAS) is a serious obstetric complication that can cause massive postpartum bleeding. During the past several decades, the prevalence of PAS has been increasing and varies from country to country. Over the past four decades, an approximately 5- to 10-fold increase in the incidence of PAS has occurred [19]. The International Federation of Gynecology and Obstetrics (FIGO) classified PAS disorders, and it has been used in clinical practice worldwide [18]. Ultrasound is the most convenient way of screening PAS patients during routine clinical visits. There are many PAS scoring systems based on ultrasound findings from different centers [15, 20, 21, 22].

This study aimed to validate a prenatal ultrasound (US) staging system for placenta accreta spectrum (PAS) disorders in women with placenta previa proposed by **Cali *et al.*** **[13]** and to evaluate its associations with surgical outcome, placental invasion, and the clinical staging system for PAS disorders proposed by the International Federation of Gynecology and Obstetrics (FIGO).

In our study, according to the PAS system, the distribution of patients in stages of the scoring system revealed that most of them had PAS grades 2 and 3. **Cali *et al.*** **[13]** reported that most women were classified as having PAS score of 0, followed by those with PAS score of 3. This difference could presumably due to the high rate of CS in Egypt.

In this study, twenty patients (35%) underwent hysterectomy. Other studies reported a lower hysterectomy rate. This may be attributed to the use of a preoperative aortic balloon, uterine artery embolization, and balloon tamponade, leading to a reduction in bleeding from the placental bed [21, 24]. CS is considered the main risk factor for placenta accreta.[25]. Although the number of previous CSs was not included in our study, we observed a statistically significant positive correlation between the PAS score and the number of previous CSs. This result is consistent with previously reported results [26, 27]. However, several studies have used the number of previous CSs in their scoring system. They reported that the combination of placenta previa, the number of prior Cesarean deliveries, and ultrasound suspicion of invasion was more predictive than ultrasound variables alone [15, 20, 21, 27].

Based on ultrasound features, several studies have reported other scoring systems to predict the degree of placental invasion. **Tovbin *et al.*** **[15]** relied on the number and size of placental lacunae, the presence of bladder wall interruption, and the obliteration of the demarcation between the uterus and the placenta in their scoring system. This scoring system differs from that reported by **Cali *et al.*** **[13]** in the number and size of placental lacunes. However, they recorded signs like those reported by **Cali *et al.*** **[13]** except for ureterovesical and parametrial hypervascularity.

In the retrospective study of **Rac *et al.*** **[20]** their scoring system was based on the combination of the smallest sagittal myometrial thickness and grading of lacunae by measuring the number and size of lacunes for the score of placental lacunae, as proposed by **Feinberg and Williams** [28] bridging vessels, the number of previous Cesarean deliveries, and the placental location. This scoring system differs from that of **Cali *et al.*** **[13]** in terms of all ultrasonographic parameters. **Zheng and colleagues** **[2]** reported another scoring system through a multicenter retrospective study (20 tertiary centers with 2219 patients), which included a combination of risk factors such as the number of CSs and ultrasonographic features. Some of these features, such as placental lacunae and loss of the "clear zone," were included in the **Cali *et al.*** **[13]** scoring system. However, other features, such as myometrial thinning, exophytic placental bulge, sub-placental hypervascularity, and extension into the bladder and cervix, were not included in the **Cali *et al.*** **[13]** scoring system. Interestingly, they also validated their scoring system at one institution (Peking University Hospital) to avoid bias in the results from different sonographers and operators at different centers. [27].

Considering the number of prediction models that have been developed, the percentage of external validation studies is small [29]. A study performed by **Alsadah *et al*.** **[30]** validated sonographic-based scoring systems for the prediction of morbidly adherent placenta (MAP) in high-risk populations [15,16,20]. They reported that **Tovbin *et al.*** **[15]** had a superior ability to predict the MAP than the other two scoring systems did. Further studies validated the scoring systems [13,14,22] . They reported that there was no single superior system [31]. **Tovbin *et al.*** **[15]** reported better diagnostic performance for PAS, as they reported specificity and positive and negative predictive values of 98.7%, 84.2%, and 97.1% respectively, and lower sensitivity values (69.6%), with an area under the curve of 0.94 [15].

Although the **Rac *et al.*** **[20]** study yielded higher specificity (100%), positive predictive value (100%), and negative predictive value (71%), with a higher area under the curve of 0.87, the sensitivity was very low compared to our results [20]. Furthermore, **Zhang *et al.*** **[2]** reported higher sensitivity (92.6%) and specificity (85.0%) than our findings when they evaluated a scoring system with maternal risk factors and the AUC was slightly greater than that when ultrasound features alone were used. Moreover, **Luo *et al.*** **[21]** reported higher positive and negative predictive values and false positive rates of the scoring system (96.68%, 95.44%, and 3.32% respectively).

The **Del Negro *et al.*** **[32]** study reported good performance, with a sensitivity of 100%, specificity of

89%, and accuracy of 92%, with an area under the curve (AUC) of 0.94 [32]. Based on the superior performance and inclusion of most ultrasonographic descriptors, this scoring system appears to be the most appropriate for the prediction of placental invasion in patients with PAS. However, it has not been validated, and external validation is needed to confirm these results. Moreover, these studies were heterogeneous, showing marked differences in their type (some were retrospective and others were prospective) and the number of included patients in each study.

External validation is important because prediction models, risk scores, and decision tools are becoming more integral parts of surgical practice. Additionally, it is necessary to assess whether a prediction model is accurate [33]. Furthermore, it is necessary to determine a prediction model's reproducibility and generalizability to new and different patients [29].

The Cali scoring system was easily applied to patients. The application of the Cali scoring system in our study could predict the presence of placenta percreta. However, the level of performance was lower than that reported by **Cali *et al.*** [13] with an area under the curve of 0.625, sensitivity of 75%, specificity of 50%, positive predictive value of 60%, negative predictive value of 66.7%, and overall accuracy of 62.5%. In contrast, **Cali *et al.*** [13] validated their scoring system in comparison with other scoring systems and reported that women with PAS2 or PAS3 were affected exclusively by placenta percreta, with higher records for the area under the curve (0.85), sensitivity (91%), and specificity (78%) [13, 31]. This difference in performance could be attributed to the number of enrolled patients (57 patients in our study versus 259 patients in the **Cali *et al.***[13] study. However, our study was designed to be prospective.

In our study, the PAS ultrasound scoring system and FIGO clinical grading system were applied prospectively. However, in the **Cali *et al.*** [13] study, the correlation between the ultrasound staging system and the clinical grading system proposed by FIGO was affected by the retrospective nature of the analysis because, at the time the study was conducted, the FIGO grading system was not yet available. It is assumed that the prospective design is better than the retrospective design, as sonographers can obtain well-scored sonograms through a targeted placental search, which compensates for the drawbacks of a retrospective study [34].

The depth of placental invasion is one of the major determinants of surgical outcome in women with a PAS disorder, with those affected by placenta percreta being at greater risk of intra-surgical complications such as massive hemorrhage, the need for blood transfusion, and damage to adjacent organs [35]. Despite the statistically non-significant relationship between the PAS stage and intraoperative complications, complications mostly occurred in PAS 3 patients (50%), whereas one patient had complications in PAS 2 patients (9.1%). This result is in agreement with the study performed by **Cali *et al.***[13] as all cases of complications occurred in PAS 3 (27.8%) and PAS 2 (25%) patients.

In our study, there was a statistically significant relationship between PAS stage and operative time, blood transfusion, fresh frozen plasma transfusion, length of hospital stays and ICU admission. This result is consistent with that previously reported by **Cali *et al.*** [13].

STRENGTHS AND LIMITATIONS

The prospective data collection provides strength for our study. Furthermore, we evaluated the correlation of the proposed staging system for PAS disorders not only with surgical outcomes but also with the depth of placental invasion and the FIGO grading system. Most of our cases were evaluated by the same expert sonographer. Patients were operated on by expert multidisciplinary teams at the PAS. Our study had several limitations. First, it was a single-center study. Second, patients affected by PAS were not managed by the same multidisciplinary team. Third, a small number of patients were included in this study.

CONCLUSION & RECOMMENDATIONS

However, the **Cali *et al.*** [13] scoring system is considered an easily applied model, and its ability to predict placental invasion was lower than that formerly mentioned in their study. Moreover, the performance of the **Cali *et al.*** [13] scoring system is not better than that of other scoring systems in the prediction of placental invasion in PAS patients despite the use of ultrasonographic findings only. Multicentered prospective studies may be needed to validate the scoring systems for the prediction of placental invasion in PAS patients by different research groups involved in clinical practice. The involvement of the number of CSs as a parameter in the scoring system may increase its predictive value.

Conflict of interest: The authors declared that there are no conflicts of interest.

Acknowledgment: The authors are grateful to all the participants for their cooperation and are grateful to all the patients included in this study.

Data availability statement: The datasets generated during and/or analyzed during the current study were available from the corresponding author upon reasonable request.

Funding Declaration: This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Consent for publication: All patients have been informed and have consented to publication.

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