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RESEARCH

A scoring system to predict the placenta accreta spectrum: a prospective study

Plasenta akreta spektrumunu öngörmeye yönelik bir skorlama sistemi: prospektif bir çalışma

Merve Öztürk Ağaoğlu[1], Turhan Çağlar[2]

[1]Department of Perinatology, Turkish Ministry of Health Ankara City Hospital, Ankara, Turkey
[2]Department of Perinatology, Turkish Ministry of Health Etlik City Hospital, Ankara, Turkey,

Abstract

Purpose: The aim of this study was to assess the utility of a scoring system using selected ultrasonographic features to predict placenta accreta spectrum (PAS) and its severity in suspicion of PAS.

Materials and Methods: This prospective study was conducted with a total of 27 pregnant women with placenta previa totalis with suspicion of PAS between 24 and 37 weeks gestation between July 2019 and January 2020. PAS score was calculated with the following parameters: loss of clear zone, number, size, and regularity of placental lacunae, turbulent flow in lacunae, uterovesical or subplacental hypervascularity, bridging vessels, and the number of previous cesarean section. Patients were divided into groups due to PAS scores and the severity of PAS. Receiver operating characteristics curves were performed to assess the performance of the PAS scoring system.

Results: In a total of 27 patients, 7 (25.9%) patients did not have PAS, 5 (18.5%) patients had accreta, 7 (25.9%) patients had increta, and 8 patients (29.6) had percreta. In groups with PAS scores higher than 8, 86% of patients had placenta percreta. PAS score was 2.8±1.4 in the no PAS group, 3.6±1.9 in the accreta group, 5.1±2.4 in the increta group, 9.8±1.6 in the percreta group and statistically higher in the percreta group. The optimal cut-off values of the PAS score to predict abnormal placental invasion was 4.5 (60% sensitivity, 86% specificity), 7.5 for differentiation percreta from increta (87.5% sensitivity, 75% specificity)

Conclusion: A PAS scoring system that combines several ultrasound and clinical characteristics may greatly improve prenatal risk assessment and prediction of PAS.

Keywords:. placenta accreta spectrum, placenta percreta, ultrasonography

Öz

Amaç: Çalışmamızın amacı, plasenta akreta spektrumu (PAS) şüphesinde, seçilmiş ultrasonografik özellikleri kullanan skorlama sisteminin, PAS ve ciddiyetini tahmin etmedeki rolünü değerlendirmektir.

Gereç ve Yöntem: Bu prospektif çalışma Temmuz 2019 ile Ocak 2020 tarihleri arasında, 24-37. gebelik haftalarında PAS şüphesi olan plasenta previa totalis tanılı toplam 27 gebe ile gerçekleştirildi. PAS skoru şu parametrelerle hesaplandı: berrak zon kaybı, plasental lakünlerin sayı, boyutu ve düzenliliği, lakün içinde türbülans akım, uterovezikal veya subplasental hipervaskülarite, köprü damarlar ve önceki sezaryen sayısı. Hastalar PAS skorları ve PAS şiddetine göre gruplara ayrıldı. PAS skorlama sisteminin performansı ROC (Receiver Operating Characteristic) eğrileri değerlendirildi.

Bulgular: Toplam 27 hastadan, 7 (%25,9) hastada PAS saptanmadı, 5 (%18,5) hastada akreta, 7 (%25,9) hastada inkreta ve 8 (%29,6) hastada perkreta saptandı. PAS skoru 8'in üzerinde olan grupta, hastaların %86'sında plasenta perkreta mevcuttu. PAS skorları, PAS saptanmayan grupta 2,8±1,4, akreta grubunda 3,6±1,9, inkreta grubunda 5,1±2,4, perkreta grubunda 9,8±1,6 olup perkreta grupbunda istatistiksel olarak daha yüksekti. Anormal plasental invazyonunu öngörmek için optimal PAS skoru 4,5 (%60 duyarlılık, %86 özgüllük), perkretanın inkretadan ayrımında optimal PAS skoru 7,5 (%87,5 duyarlılık, %75 özgüllük) saptandı.

Sonuç: Çeşitli ultrason ve klinik özellikleri kombine eden PAS skorlama sistemi, prenatal risk değerlendirmesini ve PAS prediksiyonunu büyük ölçüde iyileştirebilir.

Anahtar kelimeler: Plasenta akreta spektrumu, plasenta perkreta, ultrasonografi

Address for Correspondence: Merve Ozturk Ağaoğlu, Department of Perinatology, Turkish Ministry of Health Ankara City Hospital, Ankara, Turkey, drmerveozturk@hotmail.com
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INTRODUCTION

The placenta accreta spectrum (PAS) is an abnormal invasion of trophoblastic tissue into the myometrium[1-3]. According to how deeply the villi invade the myometrium, PAS has three categories: placenta accreta, placenta increta, and placenta percreta[4]. It may cause severe maternal-fetal adverse outcomes, even maternal mortality. The incidence of PAS has been rising, and it is widely recognized that previous placenta previa raised the risk of PAS. Patients with deep placental implantation, such as percreta and increta, have the highest risk, even though a recent study has shown that appropriate antenatal diagnosis is associated with a significant reduction in maternal hemorrhage and antepartum complications[5]. Additionally, recent research found that women with PAS who had percreta rather than accreta had much greater rates of severe morbidity[6].

The most effective screening method for PAS is ultrasound, which also helps to reduce obstetric morbidity in high-risk patients[2,6,7]. The prenatal parameters for diagnosing PAS are ultrasound findings such as the absence of retroplacental space, large irregular placental lacunae, and uterovesical and subplacental hypervascularity[8,9]. In the tertiary center, a multidisciplinary approach can be planned by identifying patients with the following features of PAS. The combination of ultrasound markers is more informative than a single parameter, which is why the scoring system for PAS has been the subject of many studies[8]. We planned to add a new scoring system to the literature about prediciton of PAS and hypothesized that the PAS scoring system could contribute to patient management by helping to determine the severity of PAS.

This study aims to develop and validate an ultrasound-based scoring system for diagnosing and predicting the severity of PAS in patients with placenta previa.

MATERIALS AND METHODS

This prospective study was conducted with 27 patients aged 18-42 between July 2019 and January 2020 in the Zekai Tahir Burak Women's Health Education and Research Hospital. The Ethics Committee of the Zekai Tahir Burak Women's Health Education and Research Hospital approved the study (Decision number: 83/2019). The Declaration of Helsinki was followed, and all participants gave written informed consent. Data collected in this study were kept confidential. They were not disclosed at any time to ensure the reliability of the records and the confidentiality and privacy of the patients participating in the study.

Sample

A sample size of 22 patients was calculated using g. power 3.1, with a desired effect size of 0.5, alpha significance level of 0.05, and 95% power. The study titled 'Risk Scoring System with MRI for Intraoperative Massive Hemorrhage in Placenta Previa and Accreta' was taken as a reference. A total of 27 pregnant women with placenta previa totalis and suspicion of PAS between 24 and 37 weeks gestation were included in the study. Maternal age, gravidity, parity, gestational age at admission, cesarean section (CS), uterine curettage, or any uterine operation were noted. Patients with (1) multiple pregnancies, (2) chorioamnionitis, (3) maternal chronic coagulation system disorders, and (4) maternal cardiac, (5) renal, (6) pulmonary diseases or (7) maternal malignancy were excluded from the study. Inclusion criteria were: (1) singleton pregnancy, (2) suspicion of PAS, (3) presence of placenta previa (4) gestational age 24-37 weeks. Although 33 patients were suspected of having PAS during the study period, the study was conducted with 27 patients who met the inclusion criteria. Placenta previa totalis is defined as the placenta completely covering the cervical os[10]. Patients were scored due to ultrasonographic criteria at admission to the hospital or in the third trimester. Classification of PAS was based on clinical features during surgery and confirmation by pathology in those cases where pathology was examined.

Scoring parameters

Ultrasound was performed by ultrasound system (voluson E8), using a 3–5 MHz abdominal transducer or vaginal transducer at a 3–9 MHz frequency at the Zekai Tahir Burak Women's Health Education and Research Hospital perinatology clinic. A transabdominal ultrasound is performed with the patient's bladder full to examine the lower uterine segment. Transvaginal ultrasonography is also performed to investigate pathologic invasion. The ultrasound scoring of the patients was performed by a maternal-fetal specialist (MOA) under the supervision of a professor of maternal-fetal medicine (TC) with 20 years of experience in this field. The

scoring system for PAS included eight parameters. The selected parameters for the study were recently reported in association with PAS[11]. Ultrasonographic parameters were included: placental lacunae, uterovesical or subplacental hypervascularity, and loss of hypoechoic retroplacental zone (clear zone) (Figure 1).

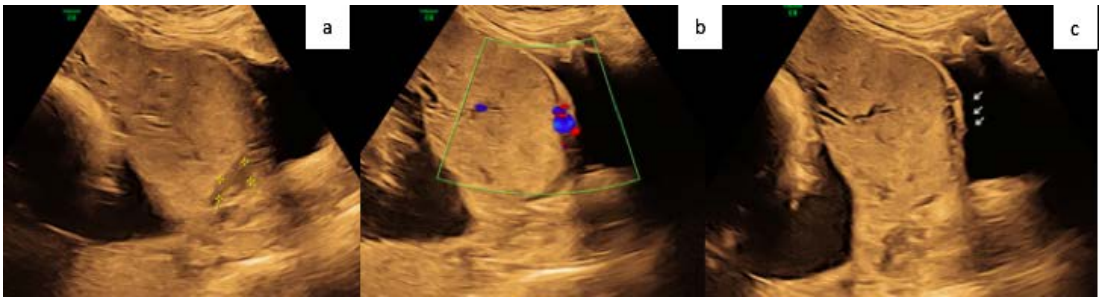

Figure 1. Ultrasonographic image sample of placenta accreta spectrum scoring system; (a) 16x11 mm placental lacunae, (b) bridging vessels, (c) loss of clear zone and irregularity in the uterus–bladder interface

Placental lacunae were classified with reference to the study of Feinberg[12]: Loss of clear zone: none (score=0), present (score=1); Placental lacunae: none seen (score=0), 1–3 present (score=1), ≥ 4–6 present (score 3); the size of placental lacunae: 0-9 mm (score=0), 10-20mm (score=1), ≥ 20 mm (score=2); irregular lacunae: none (score=0), present (score=1), turbulent flow in lacunae: none (score=0), present (score=1); uterovesical or subplacental hypervascularity: none (score=0), present (score=1); bridging vessels; none (score=0), present (score=1); number of previous CS: none (score=0), 1 (score=1), 2 (score=2), ≥ 3 (score=3) (Table 1).

The relationship between the parameters we use in scoring and PAS is related to different pathophysiological processes. It is thought that deficiencies or abnormalities in the remodeling of the spiral arteries may contribute to the development of placental lacuna. Complications of placental lacuna may result from impaired blood flow, impaired nutrient exchange, or altered placental function and angiogenesis[13]. The loss of the clear zone corresponds to the pathologic loss of the decidua basalis, as the trophoblastic tissue invades directly through the myometrium. Uterovesical/subplacental hypervascularity refers to hypervascularity observed in the subplacental area/between the myometrium and the bladder. It is indicative of abnormal invasion of trophoblastic tissue[13]. Bridging vessels are associated with neovascularization, causing disruption of the bladder wall. Previous cesarean sections cause pathological changes of the myometrium, leading to abnormal placenta invasion[14].

Table 1. Parameters of the placenta accreta spectrum scoring system

Variable	Score=0	Score=1	Score=2	Score=3
Loss of clear zone	None	Present		
Placental lacuna	None	0-3	≥ 4	
Lacuna size	0-9 mm	10-20 mm	>20mm	
Irregular lacuna	None	Present		
Turbulent flow in the lacuna	None	Present		
Uterovesical /subplacental hypervascularity	None	Present		
Bridging vessel	None	Present		
Number of previous cesarean section	0	1	2	≥ 3

Patients were divided into groups due to PAS score: group 1: 0-3, group 2: 4-8, and group 3: ≥9. Scoring groups were investigated for the percentage of PAS severity. PAS was classified according to difficulty in placental separation and pathology examination. No PAS, accreta, increta, and precreata groups were also compared by means of PAS score. Optimal score was detected for identifying PAS /non-PAS percreta / accreata. PAS scores were also compared between PAS severity groups.

Statistical analysis

SPSS (IBM SPSS Statistics 24) was performed for statistical analysis. Mean, standard deviations, median, and max-min were used for descriptive variables. The independent-sample t-test was performed for parametric data, and the Mann-Whitney U test was performed for non-parametric data. For comparisons between no PAS and PAS severity groups, the one-way analysis of variance with Bonferroni correction was used for parametric data, and Kruskal-Wallis was used for non-parametric data. Receiver operating characteristic analysis (ROC) was performed to determine the PAS score's cut-off values to predict the severity of abnormal and myometrial invasion. P-value <0.05 indicates a significant difference.

RESULTS

The clinicodemographic characteristics of patients are given in Table 2. Maternal age, body mass index, gravidity, parity, and the number of previous dilatation and curettage were similar among the groups (p>0.05). The number of CS was higher in the percreta group (p=0.009). An episode of antenatal bleeding was higher in the increta group (p=0.020).

Table 2. Clinicodemographic parameters of groups

Parameter	No PAS (n=10)	Accreta (n=11)	Increta (n=9)	Percreta (n=8)	p-value
Age (years)	30.0 (28-40)	31.0 (23-41)	32.0 (24-40)	35.0 (19-39)	0.682
Gravidity (n)	3.0 (2.0-3.0)	2.0 (1.0-4.0)	3.0 (1.0-7.0)	3.0 (2.0-5.0)	0.229
Parity (n)	2.0 (1.0-3.0)	1.0 (0.0-2.0)	2.0 (0.0-5.0)	2.0 (1.0-3.0)	0.476
Body mass index (kg/m^2)	31 (23-42)	25 (26-37)	28 (25-37)	30 (25-38)	0.741
Previous CS	1.0 (0.0-1.0)	0.0 (0.0-1.0)	1.0 (0.0-2.0)	2.0 (1.0-3.0)	0.009[a]
Previous D&C	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.622
Episode of antenatal bleeding	0.0 (0.0-2.0)	1.0 (0.0-3.0)	3.0 (0.0-5.0)	0.0 (0.0-1.0)	0.020[b]
PAS Score	2.8±1.4	3.6±1.9	5.1±2.4	9.8±1.6	0.000

[a]Between accreta and percreta group; [b]Between increta and percreta group, between percreta and other groups; CS, cesarean section; D&C, dilatation and curettage; PAS, placenta accreta spectrum p < 0.05 indicates a significant difference; Data are expressed as mean ± standard deviation, median (min-max), number (percentage)

In a total of 27 patients, 7 (25.9%) patients did not have PAS, 5 (18.5%) patients had accreta, 7 (25.9%) patients had increta, and 8 patients (29.6) had percreta. In the PAS scoring groups, in groups with PAS scores higher than 8, 86% of patients had placenta percreta. In the PAS score 4-8 group, 82% of patients had confirmed having abnormal placental invasion (Table 3).

Table 3. Comparison of scoring groups

Score	No PAS	Accreta	Increta	Percreta
0-3 (n=14)	6 (42%)	4 (28.6%)	4 (28.6%)	0 (0%)
4-8 (n=6)	1 (18%)	1 (18%)	2 (33%)	2 (33%)
≥9 (n=7)	0 (0%)	0 (0%)	1 (14%)	6 (86%)

PAS, placenta accreta spectrum, Data are expressed as numbers (percentage)

PAS score was 2.8±1.4 in the no PAS group, 3.6±1.9 in the accreta group, 5.1±2.4 in the increta group, 9.8±1.6 in the percreta group. A significant difference was found among the groups (p=0.000). In the one-way analysis of variance (ANOVA), the PAS score was detected as statistically higher in percreta compared to other groups (p=0.000) (Table 4). The Comparison of PAS scores between no PAS, accreta, and increta groups did not differ among the groups (p>0.05).

Table 4. The one-way analysis of variance analysis of PAS groups

			Mean difference	SE	Sig.	95% confidence interval	
						Lower bound	Upper bound
PAS score	No PAS	Accreta	-0.74268	1.10418	1.000	-3.9298	2.4441
		Increta	-2.28571	1.00798	0.198	-5.1950	0.6236
		Percreta	-7.01786	0.97597	0.000	-9.8348	-4.2010
	Accreta	No PAS	0.74286	1.10418	1.000	-2.4441	3.9298
		Increta	-1.54286	1.10418	1.000	-4.7298	1.6441
		Percreta	-6.27500	1.07504	0.000	-9.3779	-3.1721
	Increta	No PAS	2.28571	1.00798	0.198	-.06236	5.1950
		Accreta	1.54286	1.1.0418	1.000	-1.6441	4.7298
		Percreta	-4.73214	0.97597	0.000	-7.5490	-1.9152
	Percreta	No pas	7.01786	0.97597	0.000	4.2010	9.8348
		Accreta	6.27500	1.07504	0.000	3.1721	9.3779
		Increta	4.73214	0.97597	0.000	1.9152	7.5490

PAS, placenta accreta spectrum; SE, standard error; sig, significance, p < 0.05 indicates a significant difference

In ROC analysis to predict abnormal placental invasion, the best cut-off value of PAS score was 4.5 with 60% sensitivity and 86% specificity (Area under curve=0.829; p=0.011) (Figure 2). PAS score 7.5 had a sensitivity of 87.5% and specificity of 75% for differentiation of increta and percreta (Area under curve=0.938; p=0.003) (Figure 2).

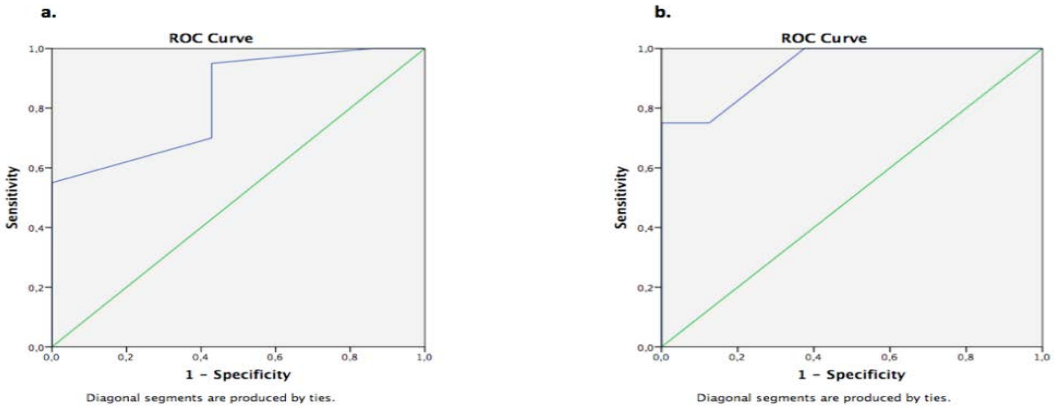

Figure 2. ROC curves of placenta accreta spectrum scoring system to differentiate placenta accreta spectrum (a) and to differentiate increata and percreta from increta (b).

DISCUSSION

This tertiary center study identified an ultrasound scoring system to evaluate PAS and its severity. We combined eight ultrasonographic parameters to score abnormal placental invasion and to provide a practical approach to antenatal PAS diagnosis. We demonstrated loss of clear zone, the presence of irregular large lacunae with turbulent flow, bridging vessels, uterovesical/subplacental hypervascularity,

and higher previous CS were associated with a high risk of PAS and the higher score was related to a higher risk of percreta. This PAS scoring system may help clinicians to manage and classify the severity of PAS.

Recent studies have developed different scoring systems; most involve several parameters[15-17]. The scoring criteria of the studies, such as the previous CS number, the placental location, or the assessment of the characteristics of the placental lacunae, may influence the cut-off and predictive value of the study[4,15,18]. In particular, in patients with placenta increta and percreta, the score is likely higher and contains more elements because these placentas have more typical PAS ultrasound signs.

Similar to our findings, previous studies showed that the history of CS is one of the scoring parameters of PAS[14,19]. Women with previous CS had pathological changes in the myometrium, such as placenta previa, that could increase the risk of abnormal placentation[14]. Loss of clear zone is currently the only direct marker for PAS. However, the specificity of this sign is controversial due to its association with false positive results[20]. The irregular placental lacunae on ultrasound is a strong predictive marker of PAS[4]. Placental venous lakes or blood sinuses are different from PAS-related placental lacunae. Placental lacunae had vessels containing high-velocity turbulent blood flow. Placental lakes are often confused with lacunas. It is essential to distinguish them from each other. Typical PAS-related lacunas are irregular, elliptical, and have feeder vessels for blood supply. Color-doppler ultrasound examination can be performed to see placental lacunae and their feeder vessels[4]. There are different gradations in placenta lacunae assessment in PAS cases. The best known are the Finberg criteria with four grades (12): grade 0: none, grade 1: 1-3 small lacunae, grade 2: 4-6 large or several irregular lacunae, and grade 3: many, large, and irregular lacunae throughout the placenta[12]. We scored placental lacunae based on this grading. Other parameters, loss of clear zone and myometrial thinning, have been considered predictors of PAS[21]. Empty bladder and thickness of abdominal fat tissue may affect ultrasound findings related to these parameters. The myometrial thickness of less than 1 mm or an area of imperceptible myometrium posterior to the placenta was considered a sign of PAS. We did not include myometrial thickness in the scoring because of its high subjectivity and because many parameters can influence the measurement. Subplacental hypervascularity has been shown to have high specificity for PAS[22]. It has previously been demonstrated that the lower anterior uterine segment subplacental blood flow velocity is higher in patients with PAS than those without PAS.

Different scoring systems were reported in the literature[23,24]. Rac et al. combined the thinner sagittal thickness of myometrium, the number of lacunae, and the bridging vessels, as well as the number of CS and the placenta location for the scoring system with the area under the curve of 0.87 to predict PAS[8]. In another recent study, authors reported that multiple previous CS, loss of clear space, higher lacunae stage, and anterior placenta location have high prediction rates for the placenta accreta diagnosis[25]. Accurate diagnosis of PAS before operation can significantly reduce maternal-fetal morbidity if delivery is performed in tertiary hospitals, so diagnostic accuracy is critical[26]. In addition, the specificity of the scoring system in placenta accreta is critical because invasive procedures such as ureteral stents, arterial embolization, or even hysterectomy may be required. In our study, several parameters combined to increase both the specificity and the positive predictive value, which may also lead to unnecessary interventions. We found that 86% of patients with a PAS score of 9 or more were found to have placenta percreta. This data can be of great use for the management of PAS. Although it is similar to other scoring systems, the fact that the parameters used are objective and practical may allow rapid assessment and preoperative preparation, especially in patients with severe bleeding or in patients admitted to the center for the first time. The scoring system was developed to ensure objectivity and experience in assessing patients. It is essential for timely referral of patients requiring a multidisciplinary approach and delivery timing to balance maternal-fetal morbidity. Collaboration with an experienced team, especially in patients with high scores, is beneficial to the patient, even if the finding is false positive. False-negative results can be reduced with training and more experience of the ultrasonographer performing the scoring system.

The relatively small number of patients is one of the limitations of this study. The small sample size may have prevented us from detecting minor differences between groups and caused higher variability. The study's other limitations are that it is not multicenter and only included patients with suspected PAS. Therefore, as we mentioned earlier, studies with more

patients are needed. Patients could follow up in the second and third trimesters to assess changes in PAS scores. The strength of our study is that patients were divided into subgroups and analyzed in detail, demonstrating the efficacy of eight-parameter ultrasound scoring.

Prenatal risk assessment and placenta accreta prediction may be greatly improved by the scoring system that combines several straightforward ultrasound and clinical characteristics. A scoring system aids medical professionals in adequately preparing for surgery and preventing perinatal morbidity and mortality. Further studies examining the relationship of PAS scoring systems with long-term postpartum outcomes may provide more detailed results for clinicians.

Author Contributions: Concept/Design : MÖA, TÇ; Data acquisition: MÖA; Data analysis and interpretation: MÖA, TÇ; Drafting manuscript: MÖA, TÇ; Critical revision of manuscript: MÖA, TÇ; Final approval and accountability: MÖA, TÇ; Technical or material support: MÖA; Supervision: MÖA, TÇ; Securing funding (if available): n/a.
Ethical Approval: This research was approved by the Ethics Committee of Zekai Tahir Burak Women's Health and Research Hospital, with the decision of the board numbered 83/2019.
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