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Original Research Article

Diagnostic Accuracy of Placenta Accreta Spectrum Scoring System (Pass Scoring) on MRI For Antenatal Diagnosis of Placenta Accreta Spectrum

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Abstract: *To decrease the chances of misdiagnosis of the placenta accreta spectrum, a scoring method must be developed based on the MRI features and the clinical presentation of patients.* ***Objective:*** *To determine the diagnostic accuracy of PAS-system on MRI to diagnose the placenta accreta spectrum, considering per operative findings after cesarean section as gold standard Study design: It was a cross sectional validation study* ***Methods:*** *The study was executed from Dec 2022 to Jun 2023 at Department of Radiology, Holy Family Hospital, Rawalpindi. Pregnant females of 2nd or 3rd trimester, aged 20-45 years, suspected for placenta accreta spectrum based on ultrasound, or those at high-risk for placenta accreta spectrum were included. Magnetic resonance imaging scan was conducted for all enrolled participants on a 1.5T scanner (Model MRI 450w optima). The MRI findings were then matched with the final diagnosis made based on the operative findings during cesarean section for all the patients. The diagnostic accuracy was evaluated in terms of sensitivity and specificity.* ***Results:*** *There were 95 participants whose mean age was 30.59±3.7 years, with an age range of 21-40 years. Around 50 (52.6%) belonged to the age group of 20 to 30. A sensitivity of 88.0%, specificity of 91.1%, positive predictive value of 91.6%, negative predictive value of 87.2% and diagnostic accuracy of 89.4% was reported.* ***Conclusion:*** *The PAS scoring system based on MRI for PAS is a highly sensitive and accurate imaging modality.*

Keywords: Placenta accreta spectrum, ultrasonography, magnetic resonance imaging, sensitivity, specificity

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Introduction

Placenta accreta spectrum (PAS), also recognised as abnormally invasive or morbidly adherent placenta, indicates abnormal tissue adherence to the myometrium of the uterus or beyond. The spectrum comprises three stages of placental tissue invasion into myometrium: 1. “Placenta accreta”, placenta attached to uterine myometrium with no invasion of decidua; 2). “Placenta incerta”, penetration of placental trophoblastic villi into myometrium; 3). “Placenta percreta”, trophoblastic villi annexing through myometrium and nearby organs (1).

The reported prevalence of placenta accreta spectrum in the United States is 2.9 cases per 1000 cesarean section deliveries (2). Manual efforts to eradicate an invaded placenta at time of labor can cause life-threatening blood loss. Severe complication of excessive bleeding, called post-partum hemorrhage (PPH), can occur when placenta fails to detach from the uterus after delivery owing to deep invasion into the uterine tissue. Extent of bleeding depends on the degree of myometrium and surrounding tissue invasion by the placenta (3). Death can occur in such circumstances as excessive blood loss may lead to various organs being failed, less severely, a hysterectomy or admission into the intensive care unit or blood transfusion might be warranted (4). Literature reports that 52.2% of women with placenta accreta spectrum undergo peripartum hysterectomy, and 46.9% had hemorrhage requiring blood transfusion during surgery (5).

Morbidity of placenta accreta spectrum is relatively high, but it can be controlled to some extent if diagnosis is made during the antenatal period. The prevalence of this disease is increasing in both developed and developing countries (2). Primarily owing to an increased elective cesarean sections, timely identification of the condition is crucial. Early diagnosis gives time to plan for appropriate labour and delivery management, significantly reducing associated morbidity.

Ultrasonography and advanced imaging techniques, including MRI, play a substantial role in establishing antenatal diagnosis of PAS. Ultrasound is a relatively more straightforward and less-expensive technique to diagnose PAS based on subjective visualisation of intra-placental lacunae within the placental parenchyma, reduced hypoechoic retro-placental zone, irregular interface between the urinary bladder and the uterus and color doppler imaging abnormalities showing hypervascularisation within the placental zone (7). Literature reports a broad range of sensitivity of ultrasound in detecting the presence and depth of PAS, ranging from 80-90%, with specificity ranging from 90-95% (8).

Due to the subjective interpretation of ultrasound findings and unclear visualisation in posterior-placenta cases, MRI is recommended as a more sensitive imaging modality to establish PAS diagnosis, especially in cases where ultrasound findings are inconclusive or for the high-risk patient population. Focal uterine bulging, heterogeneous signal intensity at intra-placental zone, focal interruptions in myometrial tissue, and T2 dark bands are the common signs used to confirm diagnosis using MRIM (9-10).

No definitive MRI feature describes the placenta accreta spectrum, and the interpretation of findings is subject to subjective assessment, which can misdiagnose patients with or without the placenta accreta spectrum. Therefore, to address the issue, efforts have been made to develop a scoring method based on both the MRI characteristics and the clinical picture of patients, which is believed to decrease the chances of misdiagnosis of placenta accreta spectrum. This cross-sectional validation study has been designed to assess the diagnostic accuracy of PAS scoring

system in predicting and diagnosing placenta accreta spectrum in pregnant females.

Methodology

We conducted a cross-sectional study from Dec 2022 to Jun 2023, at the radiology department of Holy Family Hospital, Rawalpindi. The proposal sought ethics approval from the College of Physicians and Surgeons Pakistan (CPSP). The sample size was calculated to be 95 pregnant females suspected for PAS based on ultrasonography, considering reported 85.71% and 94.87% sensitivity and specificity of placenta accreta score system[9] respectively, 52.0% prevalence of PAS,[11] 80% power of study, 95% confidence level, and 10% absolute precision.

A non-probability consecutive sampling method was utilised to approach all pregnant females presenting for antenatal care at the radiology department for routine checkups and follow-ups. Pregnant females fulfilling the inclusion criteria of belonging to 20-45 years of age, suspected with placenta accreta based on previous ultrasound, or those at increased risk for PAS were enrolled in the study. Pregnant females for whom post-op cesarean section information was not available, or those who were lost to follow up before getting diagnosis confirmation, or those contraindicated to MRI scan were excluded.

Enrolled patients provided informed consent before any data collection. Magnetic resonance imaging scan was conducted for all enrolled participants on a 1.5T scanner (Model MRI 450w optima). MRI test was performed in supine position, with moderately full bladder. MRI protocol comprised high resolution T2W images in coronal, axial and sagittal, positionings using a sequence of fast-spin-echo. T2 Fiesta and T2WI were used to evaluate the patients along the uterus axis. Radiologists reviewed MR images for reduced uterine-placenta interface, thinning of myometrium <2mm, presence of heterogeneous placenta with intra-placental vascular channels, presence of dark bands T2W and focal uterine bulge to establish diagnosis of placenta accreta. The images showing these features are given in Figures 1 and 2.

Sociodemographic and clinical data were recorded using a data collection tool for all enrolled patients. The placenta accreta spectrum score was calculated for each patient while viewing their MRI image scan reports. The scoring system was based on the clinical history of the patient and the scan's MRI features. This includes eight parameters, each carrying a score of 1. Scores from each of the eight parameters were added together to create a total score, which could range from a minimum of 0 to a maximum of 8, as shown in Table 1. The cut-off of 6 score was used to label the diagnosis as positive or negative. The MRI findings were then matched with the final diagnosis made on the operative findings during elective planned / emergency cesarean sections.

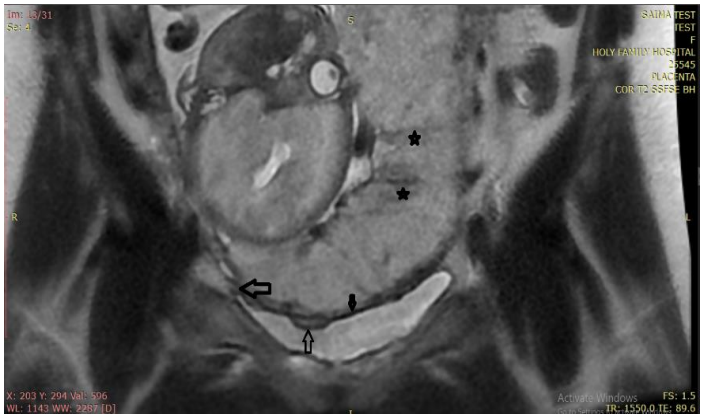

Figure 1: Stars (*) show T2 dark bands along with heterogeneous placenta, small black arrow shows loss of bladder serosa and placental interface, medium blank arrow shows focal bulge into urinary bladder and larger arrow shows loss of uterine myometrium interface along with thinning of myometrial at site of previous scar

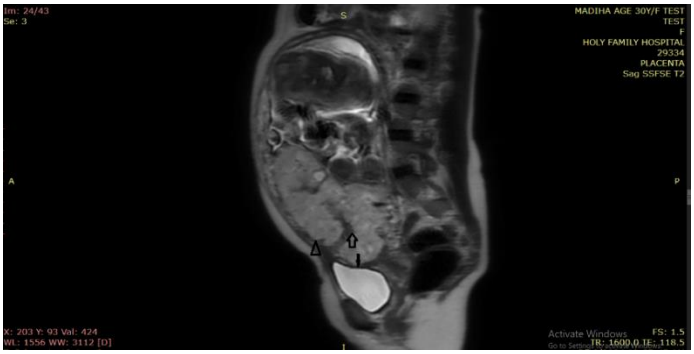

Figure 2: Arrow head shows loss of uteroplacental interface at site of previous scar, along with heterogenous placenta, small black arrow shows Loss of bladder serosa and placental interface

Table 1: Scoring details of PAS system

Criteria	Score (0/1)
History of C-section	0/1
More than one gravida	0/1
Placenta previa	0/1
Loss of uterine placenta interface	0/1
Focal thinning of myometrium	0/1
Heterogeneous placenta with inter-placental vascular channel	0/1
T2 dark bands	0/1
Focal uterine bulge	0/1
Scoring Cut-off	
• **≥6**	Positive
• **<6**	Negative

Data was extracted from the data collection tool and analysed using IBM SPSS software (version 23.0). Continuous data including PAS score, age, and number of gravidas was expressed as mean along with SD, while categorical variables were reported as frequency and percentage. Diagnostic accuracy was measured and reported. A p value of ≤0.05 was considered statistically significant.

Results

Ninety-five pregnant females were included in the study. The mean age was 30.59±3.7 years, and the age range of 21-40 years was reported. Around 50 (52.6%) participants were found to be between 20 and 30 years old. Other baseline factors including mean gestational age and mean parity are summarised in Table 2.

All the patients were subjected to magnetic resonance imaging. The placenta accreta spectrum score was calculated for each patient while viewing their MRI image scan reports. The details of PASS items and score are given in Table 3.

The PASS score was found to be positive in 48 out of 95 (50.5%) participants, where 44 out of 48 (91.6%) had placenta accreta while 4 out of 53 (8.4%) had no placenta accreta. In the remaining 47 out of 95 (49.4%) participants, the PASS score was negative, where 6 out of 47 (12.7%) had placenta accreta, while 41 out of 47 (87.2%) had no placenta accreta on operation. Table 4 gives details of diagnostic accuracy parameters.

Figure 3 describes the sensitivity and specificity values, predictive values, and overall diagnostic accuracy of the PAS system. Overall, the sensitivity and specificity of the PAS system were 88.0% and 91.1%, respectively. On the other hand, the positive and negative predictive values were 91.6% and 87.2%, respectively. The diagnostic accuracy of the PAS scoring system on MRI to diagnose the placenta accreta spectrum, keeping the per operative findings, after cesarean section as the gold standard, was found to be 89.4%.

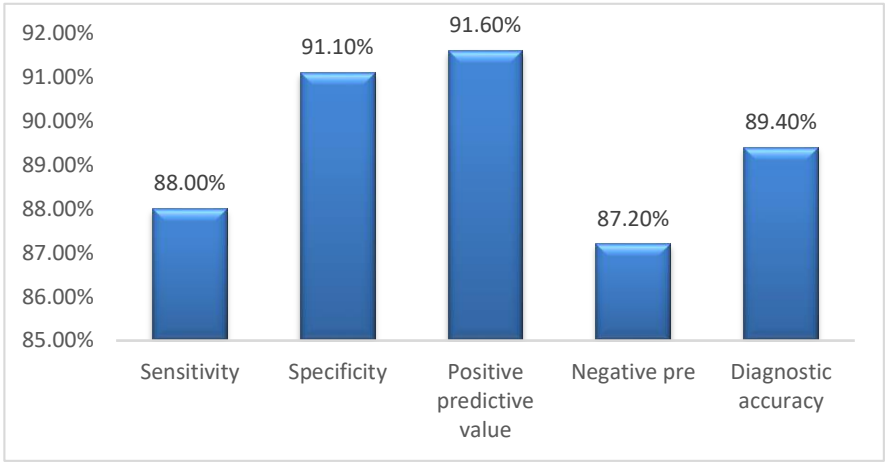

Figure 3: Sensitivity, specificity, positive and negative predictive values and overall diagnostic accuracy of the PAS system

Table 2: Summary of demographics (n=95)

Characteristics	Frequency (n)	Percentage (%)
Age of participants	27.92 ± 3.61 years	
Age range	20 - 45 years	
Age groups		
20-30 years	50	52.6%
31-45 years	45	47.4%
Mean gestational age (weeks)	38.60 ± 1.28	
Gestational age group		
37-39 weeks	70	72.7%
40-42 weeks	25	26.3%
Mean parity (no. of children)	3.24 ± 1.35	
Gravidity		
1	5	5.3%
>1	26	90.0%

Table 3: Details of PAS-system items and scoring

	Frequency (n)	Percentage (%)
History of c-section (1-score)	85	89.5%
More than one gravida (1-score)	90	94.7%
Placenta previa (1-score)	81	85.3%
Loss of uterine placenta interface (1-score)	50	52.6%
Focal thinning of myometrium (1-score)	55	57.9%
Heterogeneous placenta with inter placental vascular channel (1-score)	59	62.1%
T2 dark bands (1-score)	46	48.4%
Focal uterine bulge (1-score)	29	30.5%
Mean score (out of total 8)	5.13±2.2	

Table 4: Details of diagnostic accuracy parameters

	Positive operative findings (n=50)	Negative operative findings (n=45)	p
Positive findings on PASS score (n=48)	44[a]	04[b]	<0.001
Negative findings on PASS score (n=47)	06[c]	41[d]	

[A] True positive, [b] False positive, [c] False negative, [d] True negative

Discussion

Precise diagnosis of prenatal placenta accreta is vital for appropriate patient management. Based on this diagnosis, the patient can be better planned for delivery at hospitals with anesthesia and surgery facilities. In routine, the cesarean section can be planned around 37 weeks of gestation, when indicated, to prevent spontaneous labor. Placenta accreta is a frequently encountered significant challenge in identifying and managing the condition on clinical and diagnostic criteria. It is reported that the utility of MRI has increased in establishing the diagnosis of placenta accreta. Its utility rests with solving the diagnosis difficulties in problematic cases, which show mixed positive findings per ultrasonographic findings. In most healthcare centers, advanced imaging techniques, including MRI, are routinely used to confirm diagnosis in suspected cases, especially when the position of the placenta is either posterior. The parameters assessed on the MRI scan include bulging of the uterus at a focal point, intra-placental mixed signal intensity, dark bands at T2, and interruptions in the uterus muscle wall. In the literature, a systematic review showed the comparative diagnostic power of MRI and ultrasonography in confirming the diagnosis of PAS. Although the

diagnostic parameters of both MRI and ultrasonographic techniques can also be observed in patients with no placenta accrete (11-12).

Current study determined the diagnostic power of PAS system using MRI considering the per-operative findings during cesarian section to diagnose placenta accreta as the gold standard. This study reported a sensitivity of 88.0%, specificity of 91.1%, positive predictive value of 91.6%, negative predictive value of 987.2% and diagnostic accuracy of 89.4% for PAS to establish diagnosis.

Tanimura et al (13). A scoring system was reported to have been developed to predict the invasive placenta in patients with previa based on previous history of C-section, ultrasound, and MRI findings. The scoring system had a minimum score of 8 and a maximum score of 24 that was reported to have 91.3% sensitivity and 98.0% specificity. The only difference in this study is that the population included only placenta previa patients. Researchers including Knight et al (14). Reported to utilise both ultrasound and MRI techniques to establish diagnosis of PAS, and reported 56.0% sensitivity of this method, while specificity of 92.0% was reported. The sensitivity reported by the author is significantly lower than what has been reported in this study, the primary reason can be the dynamics of the study population involved in the study, along with the method of scoring utilised by the authors to confirm PAS in pregnant females.

In a meta-analysis including twenty studies, Familiari A et al, (15). The reported 94.4% diagnostic sensitivity of advanced MRI imaging technique confirmed the adhesion of the placenta to the uterine muscle, 100% confirmed the implantation of the wall, and 86.5% confirmed the penetration of the wall. The authors concluded that the MRI scoring system has significant diagnostic power in diagnosing these conditions. This study included slightly different conditions diagnosed using MRI, which are closely related to PAS; thus, the results are very much in line with current research.

Literature reported that Mahalingam HV et al (9). A study was conducted to assess the predictive value of the PAS scoring method and confirm PAS in pregnant females. The authors reported 90% and 28.5% prevalence of PAS in the study population at high and moderate risk. The results concluded 85.7% sensitivity, 94.9% specificity, and 92.5% diagnostic accuracy of the same to diagnose PAS. Chu et al (10). Also reported to use scoring based on MRI characteristics to predict the PAS in high-risk pregnant females. The authors reported a cut-off value of 4.5 with sensitivity of 94.3%, whereas 90% specificity was reported along with overall accuracy of 92.3%.

Literature also reported that Balcacer et al (16). Two assessors examined the PAS condition in the study population using the MRI technique. They reported a good inter-rater reliability of the PAS method to predict the presence of invasive placenta. Authors including Morel et al (17). Reported the prediction of penetrating placenta using a criterion based on the MRI features of the PAS scoring method. The reported results were closely aligned with the results of the current study. The authors concluded that the MRI-based scoring method is a robust way of predicting and confirming the presence of invasive placenta in high-risk populations, and its utility can be invaluable in timely decision-making and overall patient management with better outcomes.

There were some limitations in the current study, including that the data were collected from a single-center tertiary care hospital. Secondly, considering time and resource constraints, the sample size was below a hundred. On the other hand, the study's strengths include its prospective nature, expert radiologist assessed the scores, and the scores were related to the depth of invasion, the placenta. There is limited data reported on this topic from our local context. The study's strengths are that it contributed to providing local data from Pakistan and providing some evidence on the utility of the PAS system scoring method to diagnose PAS.

Conclusion

This study concluded that the placenta accreta spectrum scoring system (PAS-system) on MRI for PAS is a highly sensitive and accurate imaging modality, and can significantly contribute towards establishing the diagnosis of PAS and improve patient management for better outcomes. The PAS system on MRI is recommended for routine identification of PAS for timely diagnosis and management.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-MMNCS-0331d-24)

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

SJ (PGR)
Manuscript drafting, Study Design,
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Review of Literature, Data entry, Data analysis, and drafting article.
AM (MO)
Conception of Study, Development of Research Methodology Design,
NB (PGR)
Study Design, manuscript review, critical input.
SM (PGT),
Manuscript drafting, Study Design,
AZ (Associate Professor)
Review of Literature, Data entry, Data analysis, and drafting article.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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