Section: Miscellaneous

Original Research Article

DIAGNOSIS OF PLACENTA ACCRETA SPECTRUM IN POST-CAESAREAN PREGNANCY: A COMPARATIVE STUDY OF ULTRASOUND AND MAGNETIC RESONANCE IMAGING

Thendral G[1], Laishram Trinity Meetei[2], Laishram Deepak Kumar[1], Keisham Miranda Devi[1], Sheral Raina Tauro[1], Tamphasana Maimom[1]

[1]Senior Resident, Department of Radiodiagnosis, Regional Institute of medical Sciences, Imphal, Manipur, India
[2]Assistant Professor, Department of Obstetrics and Gynecology, Regional Institute of medical Sciences, Imphal, Manipur, India
[3]Associate Professor, Department of Pathology, Regional Institute of medical Sciences, Imphal, Manipur, India

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Corresponding Author:
Dr. Thendral G,
Senior Resident, Department of Radiodiagnosis, Regional Institute of medical Sciences, Imphal, Manipur, India.
Email: thendralg1998@gmail.com

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ABSTRACT

Background: Placenta accreta spectrum (PAS) is a life-threatening obstetric condition associated with abnormal placental invasion and rising caesarean section rates. Early diagnosis is essential for optimal management. This study evaluated the diagnostic performance of ultrasonography (USG) and magnetic resonance imaging (MRI) in post-caesarean pregnancies.

Materials and Methods: A cross-sectional study was conducted over two years at RIMS, Imphal, including 84 pregnant women with prior caesarean section. All underwent USG, and MRI was performed in suspected cases. Histopathology was the gold standard. Data were analyzed using SPSS with chi-square test, t-test, and ROC analysis.

Results: Most participants were aged 18–27 years (54%) with a mean age of 33.23 ± 5.91 years. Higher gravidity and multiple LSCS were significantly associated with PAS ($p < 0.05$). MRI showed higher sensitivity (65.3%) and specificity (77.3%) compared to USG (55.2% and 63.6%). ROC analysis indicated moderate diagnostic accuracy (MRI AUC = 0.614; USG AUC = 0.682).

Conclusion: USG and MRI are effective for PAS diagnosis, with MRI showing better diagnostic performance. Multiparity and prior LSCS significantly increase PAS risk, highlighting the need for early detection and multidisciplinary management.

Keywords: Placenta accreta spectrum, ultrasonography, MRI, caesarean section, multiparity, diagnostic accuracy.

INTRODUCTION

Placenta accreta spectrum (PAS) represents a group of abnormal placental implantation disorders characterized by defective decidualization and abnormal trophoblastic invasion into the myometrium. It encompasses placenta accreta (superficial attachment), placenta increta (invasion into the myometrium), and placenta percreta (penetration through the myometrium and serosa, sometimes involving adjacent organs).[1] PAS is a potentially life-threatening obstetric condition associated with severe maternal morbidity, including massive obstetric hemorrhage, need for blood transfusion, peripartum hysterectomy, and increased maternal mortality.[2,3] The global rise in caesarean section rates has led to a parallel increase in the incidence of PAS, making it a significant clinical challenge in contemporary obstetrics. Previous caesarean delivery is the most important risk factor, with the risk increasing proportionally with the number of prior caesarean sections. Other associated risk factors include placenta previa, prior uterine surgeries (such as myomectomy or curettage), advanced maternal age, assisted reproductive techniques, and endometrial damage.[4,5] The coexistence of placenta previa and prior caesarean section markedly elevates the risk of PAS,

underscoring the importance of vigilant antenatal surveillance in high-risk pregnancies.

Early and accurate antenatal diagnosis of PAS is critical for optimizing maternal and fetal outcomes. Prenatal identification enables planned delivery in a tertiary care center with a multidisciplinary team, including experienced obstetricians, anesthesiologists, neonatologists, and interventional radiologists, thereby reducing complications and improving prognosis.[6] The standard management approach in most cases is planned caesarean hysterectomy with the placenta left in situ, as attempts at placental removal can result in catastrophic hemorrhage.Imaging plays a central role in the antenatal diagnosis of PAS. Ultrasonography, including transabdominal and transvaginal approaches, is the first-line imaging modality due to its wide availability, safety, and high diagnostic accuracy. Key sonographic features suggestive of PAS include loss of the retroplacental clear zone, myometrial thinning, presence of placental lacunae, and increased vascularity at the uteroplacental interface.[6] However, the diagnostic accuracy of ultrasound may be influenced by operator expertise and equipment quality.Magnetic resonance imaging (MRI) serves as a valuable adjunct, particularly in cases with inconclusive ultrasound findings or when detailed assessment of the depth and extent of placental invasion is required. MRI offers superior soft tissue contrast and multiplanar imaging capabilities, aiding in better delineation of myometrial invasion and involvement of adjacent structures such as the bladder.[7–9] Typical MRI features of PAS include uterine bulging, dark intraplacental bands, focal interruptions in the myometrial wall, and abnormal placental vascularity. Despite these advantages, variability in reported diagnostic accuracy persists, and both overdiagnosis and underdiagnosis can occur when either modality is used independently.[10-12] Although histopathological examination remains the gold standard for definitive diagnosis, it is usually performed postoperatively and therefore has limited utility in antenatal decision-making.[13,14] Given the limitations of individual imaging modalities, there is a growing need to evaluate and compare their diagnostic performance, especially in high-risk populations such as post-caesarean pregnancies.Women with PAS often experience significant intraoperative blood loss, averaging 3–5 litres, and a substantial proportion require massive transfusion support.[15] Therefore, accurate prenatal diagnosis is essential for adequate preparation, including blood product availability, surgical planning, and critical care support, which ultimately reduces maternal morbidity and mortality.

In this context, the present study was conducted to evaluate and compare the diagnostic accuracy of ultrasound and magnetic resonance imaging in detecting placenta accreta spectrum in post-caesarean pregnancies. The study also aimed to assess specific imaging features that may improve the prediction and differentiation of PAS, thereby facilitating timely diagnosis and optimal clinical management.

MATERIALS AND METHODS

Study Design: A hospital-based cross-sectional study was conducted in the Department of Radiodiagnosis, Regional Institute of Medical Sciences (RIMS), Imphal. Patients presenting in both outpatient and emergency settings were included consecutively.

Study Setting: The study was carried out at RIMS, Imphal, Manipur, a 1074-bedded tertiary care teaching hospital catering to the northeastern region of India. The institute is equipped with advanced diagnostic facilities and manages a high patient load, providing services to over 2.4 lakh outpatients and more than 31,000 inpatients annually.

Study Duration: The study was conducted over a period of two years, from April 2023 to March 2025.

Study Population: Pregnant women referred from the Department of Obstetrics and Gynecology for antenatal ultrasonography were included. All eligible participants fulfilling the inclusion criteria were enrolled.

Inclusion Criteria

- Pregnant women aged 18–45 years with a history of previous caesarean section
- Patients providing informed consent for participation

Exclusion Criteria

- Patients with an unscarred uterus
- Refusal to undergo MRI examination
- Contraindications to MRI (e.g., cardiac pacemakers, metallic implants, claustrophobia)

Sample Size: The sample size was calculated based on a previous study by Ayati et al. (2017), which reported a minimum sensitivity of 76% for imaging modalities in diagnosing placenta accreta. Considering a prevalence of 21%, a confidence level of 95% (Z = 1.96), and a confidence interval width of 20%, the calculated sample size was 84.

Sampling Technique: Convenience sampling was employed, and all eligible patients referred during the study period were included.

Ethical Considerations: Ethical approval was obtained from the Research Ethics Board of RIMS, Imphal (Approval No: A/206/REB-Comm(SP)/RIMS/2015/1058/89/2023). Written informed consent was obtained from all participants. Confidentiality and privacy were strictly maintained, and data were accessible only to the investigators.

Study Variables

- Independent variables: Age, residence (urban/rural), occupation, educational status
- Outcome variable: Radiological profile of placenta accreta spectrum (PAS) based on ultrasound and MRI findings

Operational Definitions

Ultrasound Findings Suggestive of PAS:

- Placenta previa

- Placental lacunae (moth-eaten/Swiss cheese appearance)
- Abnormal color Doppler vascularity
- Focal uterine bulge
- Loss of retroplacental clear space
- Myometrial thinning (<1 mm) or non-visualization
- Disruption of retroplacental blood flow
- Irregular bladder wall with increased vascularity

MRI Findings Suggestive of PAS:

- Placenta previa
- Uterine bulging
- Heterogeneous placental signal intensity
- Dark intraplacental bands on T2-weighted images
- Focal myometrial interruptions
- Bladder tenting
- Direct invasion of adjacent pelvic structures

The diagnosis of PAS was confirmed intraoperatively (difficulty in placental removal, excessive bleeding) and/or by histopathological examination.

Study Tools

- Predesigned data collection proforma
- Ultrasound machine: Samsung Medison HS70A
- MRI scanner: Siemens 3.0 Tesla (MAGNETOM Skyra, Erlangen, Germany)

Methodology

All enrolled patients underwent ultrasonographic evaluation using a Samsung Medison HS70A machine with a 3.5–5 MHz transducer. Scanning was performed in the supine position with a partially filled urinary bladder. Gestational age was determined using standard biometric parameters such as biparietal diameter and femur length.

Patients with previous caesarean section or suspected placental abnormalities underwent MRI using a Siemens 3.0T scanner. Imaging was performed in a comfortable position (supine or left lateral decubitus). The MRI protocol included HASTE sequences in sagittal, coronal, and axial planes with 8-mm slice thickness and an effective echo time of approximately 90 ms. Additional targeted oblique sequences were obtained perpendicular to the placenta-myometrial interface. T1-weighted gradient echo sequences were also acquired for better delineation of placental invasion and surrounding structures. The total scan duration was approximately 15–20 minutes.

Data Collection: Data were collected using a structured proforma, including demographic details, clinical history, obstetric history, and imaging findings.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 23 (IBM Corp.). Continuous variables were expressed as mean ± standard deviation or median (IQR), while categorical variables were presented as frequencies and percentages. Associations between categorical variables were analyzed using the Chi-square test or Fisher's Exact test as appropriate. Correlation analysis was performed using Pearson's or Spearman's correlation based on data distribution. Diagnostic performance of ultrasound and MRI was assessed by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy. A p-value <0.05 was considered statistically significant.

RESULTS

The age-wise distribution of the study population demonstrated that the majority of participants belonged to the 18–27 years age group (54%), followed by 28–37 years (32%) and 38–47 years (14%). The mean age of the study population was 33.23 ± 5.913 years, indicating that most patients were within the active reproductive age group.

A statistically significant association was observed between gravida status and USG findings (χ^2 = 64.574, p < 0.001). Primigravida cases showed placenta previa with PAS exclusively. Gravida 2 and 3 groups had predominantly normal findings (23/28 and 15/29, respectively), though cases of PAS and previa with PAS were also noted. Higher gravidity (Gravida 4 and 5) demonstrated an increasing trend of abnormal placentation, particularly previa with PAS, indicating a higher risk in multiparous women. There was a statistically significant association between gravida status and MRI findings (χ^2 = 28.937, p = 0.004). Gravida 1 cases showed only accreta. Gravida 2 and 3 groups had a higher proportion of normal findings (15 cases each), along with accreta, increta, and percreta cases. In Gravida 4 and 5, there was a notable increase in abnormal placentation, particularly accreta and increta, with Gravida 5 showing only accreta cases, suggesting a strong association between increasing gravidity and PAS.A statistically significant association was observed between gravida and HPE findings (χ^2 = 26.666, p = 0.009). Gravida 2 and 3 groups showed the highest proportion of normal findings (14 and 12 cases, respectively). However, Gravida 3 also had a substantial number of percreta cases (12/32). Gravida 4 and 5 showed an increased prevalence of increta and percreta, with no normal cases in Gravida 5, confirming a higher risk of PAS with increasing gravidity. A significant association was found between the number of LSCS and USG findings (χ^2 = 11.289, p = 0.024). Among patients with one prior LSCS (n = 56), normal findings were most common (30 cases). In contrast, patients with two LSCS (n = 28) showed a higher prevalence of previa with PAS (18 cases) and fewer normal findings, indicating an increased risk of abnormal placentation with repeated caesarean sections. MRI findings also showed a statistically significant association with LSCS (χ^2 = 8.978, p = 0.030). Patients with one LSCS had predominantly normal findings (40/58), whereas those with two LSCS demonstrated a higher proportion of accreta cases (16/26) and fewer normal findings, suggesting an increased risk of PAS with multiple caesarean deliveries.

A significant association was observed between LSCS and HPE findings (χ^2 = 10.898, p = 0.012).

Patients with one LSCS showed predominantly normal findings (40/58), while those with two LSCS had a higher prevalence of increta (12 cases) and fewer normal findings, confirming the increased risk of PAS disorders with repeated caesarean sections. Independent t-test analysis revealed a statistically significant difference between HPE and MRI ($p = 0.02$) and between HPE and USG ($p < 0.001$), while no significant difference was observed between MRI and USG ($p = 0.365$). The mean values were 1.91 ± 1.139 for HPE, 1.32 ± 0.949 for MRI, and 1.42 ± 0.848 for USG. These findings suggest that MRI and USG show comparable results, whereas both differ significantly from HPE.ROC analysis demonstrated that MRI had an area under the curve (AUC) of 0.614 (95% CI: 0.449–0.778, $p = 0.04$), with sensitivity of 65.3% and specificity of 77.3%. USG showed a higher AUC of 0.682 (95% CI: 0.524–0.840, $p < 0.001$), with sensitivity of 55.2% and specificity of 63.6%.

Table 1: Baseline Characteristics of Study Population (n = 84)

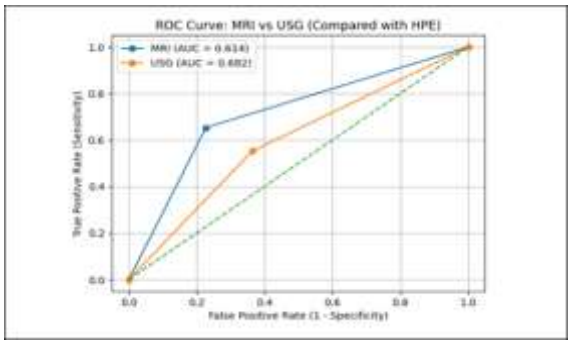
Parameter	Category	n	%	Mean ± SD
Age (years)	18–27	45	54	33.23 ± 5.91
	28–37	27	32	
	38–47	12	14	
Gravida	G1	5	6.0	
	G2	28	33.3	
	G3	29	34.5	
	G4	10	11.9	
	G5	12	14.3	
LSCS	1	56	66.7	
	2	28	33.3	

Table 2: Association of Risk Factors (Gravida & LSCS) with PAS (Combined Findings)

Variable	Category	Normal n (%)	PAS / Previa + PAS n (%)	p-value	Statistical Test
Gravida	G1	0 (0%)	5 (100%)	<0.001	Chi-square
	G2	23 (82.1%)	5 (17.9%)		
	G3	15 (51.7%)	14 (48.3%)		
	G4	2 (20.0%)	8 (80.0%)		
	G5	0 (0%)	12 (100%)		
LSCS	1	30 (53.6%)	26 (46.4%)	0.024	Chi-square
	2	6 (21.4%)	22 (78.6%)		

Table 3: Diagnostic Performance of USG and MRI Compared with HPE

Parameter	AUC	95% CI	Sensitivity (%)	Specificity (%)	p-value
MRI vs HPE	0.614	0.449–0.778	65.3	77.3	0.04
USG vs HPE	0.682	0.524–0.840	55.2	63.6	0.00



DISCUSSION

The present study evaluated the association between gravidity, prior lower segment caesarean section (LSCS), and placenta accreta spectrum (PAS), along with the comparative diagnostic performance of ultrasonography (USG) and magnetic resonance imaging (MRI) using histopathological examination (HPE) as the reference standard. The findings demonstrated that increasing gravidity and prior caesarean deliveries were significantly associated with a higher risk of PAS, and both USG and MRI showed moderate diagnostic accuracy in its detection.

The age distribution in this study revealed that the majority of patients were in the 18–27 years age group (54%), followed by 28–37 years (32%), with a mean age of 33.23 ± 5.913 years. This reflects the typical reproductive age group, which is consistent with previous studies reporting that PAS and other obstetric complications are most commonly encountered in women of reproductive age.[16] Although advanced maternal age is a recognized risk factor for abnormal placentation,[17] the present study suggests that younger women with increased parity and prior uterine interventions also constitute a high-risk group.

A statistically significant association was observed between higher gravida status and PAS across USG, MRI, and HPE findings. Patients with Gravida 4 and 5 demonstrated a markedly increased prevalence of PAS-related abnormalities, including accreta, increta, and percreta. These findings are in agreement with earlier studies that have identified multiparity as an important risk factor for PAS due to repeated uterine trauma and endometrial damage.[3,18] Jauniaux et al. also reported a progressive increase in PAS incidence and severity with increasing parity,[19] supporting the trends observed in the present study.

Similarly, a significant association was found between the number of prior LSCS and PAS. Patients with two previous caesarean sections had a higher frequency of abnormal placentation compared to those with a single LSCS. This observation aligns with Bowman et al., who demonstrated that the risk of PAS increases significantly with the number of prior caesarean deliveries.[20] The underlying mechanism is attributed to defective decidualization and poor healing at the uterine scar site, facilitating abnormal trophoblastic invasion.[6]

In the present study, intergroup comparison showed a statistically significant difference between HPE and MRI ($p = 0.02$) as well as between HPE and USG ($p < 0.001$), while no significant difference was observed between MRI and USG ($p = 0.365$). These findings indicate that although USG and MRI provide comparable results, both differ from histopathological findings, reaffirming that HPE remains the gold standard for definitive diagnosis.[21] ROC curve analysis demonstrated that MRI had higher sensitivity (65.3%) and specificity (77.3%) compared to USG (55.2% and 63.6%, respectively), although USG showed a slightly higher area under the curve (AUC: 0.682 vs 0.614). These findings are comparable to the study by D'Antonio et al., which reported superior diagnostic performance of MRI, particularly in detecting deeper invasion such as increta and percreta.[5] Similarly, a meta-analysis by Pagani et al. confirmed that MRI provides improved accuracy in assessing the depth and extent of placental invasion.[22] Despite this, USG remains the primary screening modality due to its availability, safety, and cost-effectiveness, while MRI is reserved for equivocal or high-risk cases.

The increasing global rate of caesarean deliveries has been directly associated with the rising incidence of PAS.[23] The present study reinforces the importance of targeted antenatal screening in high-risk groups, particularly multiparous women and those with prior LSCS. Early diagnosis allows for planned delivery in tertiary care centers, thereby reducing maternal morbidity and mortality.

A major strength of this study is the use of a multimodal diagnostic approach incorporating USG, MRI, and HPE, enabling comprehensive evaluation and comparison of diagnostic accuracy. The inclusion of varying gravida categories enhances the generalizability of the findings within high-risk obstetric populations.

However, certain limitations should be considered. The study population predominantly included multiparous women with prior LSCS, which may limit applicability to low-risk groups. Additionally, both USG and MRI are operator-dependent, and variability in interpretation may influence diagnostic outcomes. The study also did not assess maternal and neonatal outcomes, which are crucial for understanding the full clinical impact of PAS. Furthermore, the higher cost and limited accessibility of MRI may restrict its routine use in resource-limited settings.

Despite these limitations, the present study provides important evidence supporting the association between higher gravidity, prior LSCS, and PAS. It highlights the diagnostic utility of USG and MRI and emphasizes the importance of early detection and multidisciplinary management in improving maternal and fetal outcomes in placenta accreta spectrum disorders.

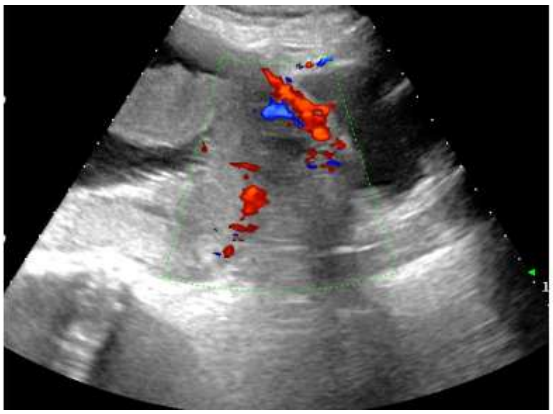


Figure 1: Sagittal Colour Doppler image showing bridging vessels in the uterine bladder (UB) interface with irregularity and intraluminal extension of the placenta into the UB.

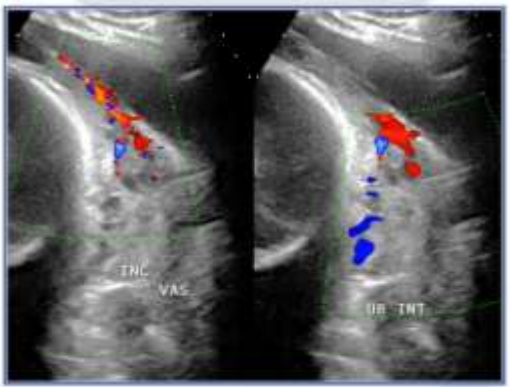


Figure 2: Sagittal colour Doppler image showing the presence of blood vessels at the level of the uterine bladder (UB) interface.

Figure 3: Sagittal US images shows anteriorly located low lying placenta with presence of focal myometrial bulge in lower uterine segment along the UB interface

CONCLUSION

The present study highlights the significant association between gravida status, prior lower segment caesarean section (LSCS), and the occurrence of placenta accreta spectrum (PAS) disorders. The majority of patients were within the reproductive age group, with a mean age of 33.23 ± 5.913 years, indicating that PAS is predominantly encountered in women of active childbearing age.A strong and statistically significant relationship was observed between increasing gravidity and PAS across all diagnostic modalities. Higher gravida (Gravida 4–5) was associated with a greater prevalence of abnormal placentation, including placenta previa with PAS and its severe forms. Similarly, a significant association was found between prior LSCS and PAS, with women having multiple caesarean deliveries demonstrating a markedly increased risk. These findings reaffirm that both multiparity and repeated uterine surgery are key risk factors for abnormal placental implantation. Comparative analysis of diagnostic modalities revealed that ultrasonography (USG) and magnetic resonance imaging (MRI) showed comparable performance, with no significant difference between them. However, both differed significantly from histopathological examination (HPE), which remains the gold standard for definitive diagnosis. ROC analysis demonstrated moderate diagnostic accuracy for both USG and MRI, with MRI showing better sensitivity and specificity, while USG exhibited slightly higher overall discriminatory ability. Overall, the study emphasizes the importance of early antenatal diagnosis and risk stratification in women with high gravidity and previous LSCS. Ultrasonography should be utilized as the primary screening tool, while MRI serves as a valuable adjunct for detailed assessment in high-risk or inconclusive cases. A multidisciplinary approach with planned delivery in tertiary care settings is essential to reduce maternal morbidity and mortality associated with PAS.

Limitations of the study: This study was conducted at a single center with convenience sampling, limiting generalizability. The population was predominantly multiparous with prior LSCS, which may not represent low-risk groups. Imaging findings (USG and MRI) were operator-dependent, introducing potential variability. Additionally, maternal and neonatal outcomes were not assessed, and MRI accessibility may limit its routine use.

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