Unveiling Placenta Accreta Spectrum: Magnetic Resonance Imaging for Predictive Insights with Intraoperative and Histopathological Correlation

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Abstract: *Introduction: Placenta accreta spectrum (PAS) poses a significant risk during pregnancy, characterized by abnormal placental adherence or invasion into surrounding tissues, often stemming from defects in the spongiosus layer of the placenta basalis. While ultrasound serves as the primary imaging modality, its limitations in visualizing deep-seated placental invasion necessitate the use of magnetic resonance imaging (MRI) for comprehensive evaluation. Objective: Principle objective of this study is to improve prenatal diagnostic accuracy of PAS by placental MRI in high risk pregnant women for PAS. Materials and methods: This retrospective descriptive study was conducted in Department of Radio diagnosis at P.D.U. Medical College and Civil Hospital (tertiary care government centre) from May 2023 to December 2023.This retrospective study has included 23 pregnant women in 2nd and 3rd trimester with high risk of PAS, based on previous history of caesarean delivery or uterine surgery. Intraoperative and final Histopathological impression was compared with available antenatal reported MRI parameter for PAS. Results: Our study has shown that there is high positive coherence between placental invasion and placenta preavia and this was present in all of our cases. Placental heterogeneity and T2 dark placental bands have high coherence with placental invasion but were not specific. Uterine bulge has high specificity for placenta percreta disorder. Conclusion: The escalating incidence of PAS disorders parallels the increasing rate of caesarean deliveries. Accurate antenatal diagnosis and identification of extrauterine invasion are crucial for multidisciplinary planning and improved patient outcomes. While ultrasound remains the initial investigation of choice, MRI serves as a valuable adjunct in cases with inconclusive ultrasound findings, aiding in operative planning by delineating the extent of placental invasion. The integration of multiple MRI features in suspected high-risk pregnant women facilitates the accurate diagnosis of underlying PAS, guiding optimal management strategies.*

Keywords: placenta, placental invasion, pas, uterine bulge, T2 dark band. accreta, increta, percreta.

Abbreviations: Placenta accrete spectrum: PAS, Magnetic resonance imaging: MRI

1. Introduction

In recent years, increasing studies are exploring the diagnostic value of magnetic resonance imaging (MRI) for placenta accreta. Compared with traditional ultrasound, MRI has the advantages of high-resolution, multiplanner visualisation, and less interference by amniotic fluid and intestinal gas. However, the reported diagnostic accuracy among studies was inconsistent. Therefore, this study is aimed at exploring the diagnostic value of MRI for placental myoinvasion.

Placenta accreta spectrum (PAS) encompasses a range of disorders, including placenta accrete, increta, and percreta, distinguished by the depth of chorionic villi invasion into the myometrium due to defects in the spongiosus layer of the decidua basalis. Placenta accreta entails villi attachment to the myometrium without invasion, while increta involves partial invasion and percreta penetrates the entire myometrium, often extending to adjacent organs. Definitive diagnosis typically occurs at delivery, employing a combination of clinical and histopathologic criteria, as outlined by the International Federation of Gynaecology and Obstetrics (FIGO) classification system.

These conditions pose significant risks, including intractable haemorrhage necessitating multiple blood transfusions and maternal morbidity and mortality during the peripartum period. Major risk factors for PAS include placenta previa and a history of prior surgeries, particularly caesarean sections and curettage. Timely prenatal diagnosis is paramount, facilitating the planning of caesarean sections in tertiary healthcare centres equipped with comprehensive maternal and neonatal intensive care units.

While ultrasound remains the primary non-invasive imaging modality for PAS assessment, its efficacy may be limited by factors such as posterior placentation, obesity, and operator experience. Magnetic resonance imaging (MRI) emerges as a valuable adjunct to ultrasound, offering superior spatial resolution of the entire placenta and improved delineation of uterine and adjacent anatomical structures. By providing detailed assessments of myometrial invasion, MRI enhances surgical planning and facilitates multidisciplinary management approaches.

This study aims to evaluate the preoperative MRI features of placental adherence and invasion in high-risk pregnant women, correlating these findings with surgical and histopathologic results to ascertain the accuracy of MRI in prenatal PAS diagnosis. Enhancing radiologists' confidence and ability to interpret MRI findings will not only improve diagnostic accuracy but also optimize treatment planning, ultimately enhancing patient outcomes in PAS cases.

Objectives:
- Correlation of placental MRI parameters for PAS with intraoperative and final histopathological impression.
- Improving prenatal diagnostic accuracy of PAS by placental MRI in high-risk pregnant women.

2. Materials and methods

Patient selection
A retrospective observational study was conducted on pregnant women (total 23 patients) in their 2nd or 3rd trimester, with risk factor for PAS, who visited obstetric department from May 2023 to December 2023.

Risk factors for suspicion of PAS considered in this study were Ultrasound diagnosed placenta preavia, History of previous caesarean delivery or uterine surgery.

Inclusion criteria: Pregnant women with high risk factors for PAS with MRI placenta done in 2nd/3rd trimester and subsequently underwent Caesarean delivery.

MRI protocol:
All MRI examinations were performed on 1.5T scanner (Siemens), after injection of an anti- peristaltic drug and partial full urinary bladder. No intravenous contrast was used.

Imaging protocol included following sequences: T2W half Fourier in sagittal, axial and coronal planes (FOV: 320-430 mm, slice thickness: 5 mm, TR / TE (msec):800/85, flip angle: 120°). Sagittal FAT SAT T1W sequence – FOV: 320-400 mm, Slice thickness: 5 mm, TR / TE (msec): 4.35/4.61, flip angle: 10°. DWI – axial or sagittal FOV: 320-400 mm, slice thickness: 5 mm, TR / TE (msec): 3200/75, flip angle: 10°.

All placental MRI scans were interpreted for specific features by expert radiologists and final radiologic impression was formed as-
1) Normal placenta-no placental invasion (NP),
2) Placenta accreta-increta spectrum (AIS) and
3) Placenta percreta (PP).

All pregnant women (with high risk for PAS disorders) underwent caesarean delivery (with counselling of relatives regarding hysterectomy, if needed) at fully equipped referral tertiary care centre and intra operative –histopathological (for whom sample was sent to histopathology lab) findings were tabulated.

Intra operative findings considered in this study to make operative impression:
1) Easy separation of placenta.

2) Preservation of uterine serosa with difficult separation of placenta or visible loss of placenta-myometrial interface- (placenta accreta-increta spectrum) or
3) Frank invasion of uterine serosa or bladder invasion or uterine rupture (placenta percreta).

Histopathology findings for the placenta (in cases of caesarean delivery) or the placenta and uterus (in cases of hysterectomy) were recorded for the presence or absence of invasion and final Histopathological impression was formed as:
1) Placenta accrete
2) Placenta increta
3) Placenta percreta

3. Results

In our study mean maternal age 31 years and mean gestational age at time of MRI was 26 weeks. [Table/Fig 1].

High association was observed between of PAS disorder in current pregnancy with number of previous caesarean delivery.

Those caesarean deliveries (10 females) where placental separation was easy and smooth maternal surface was noted did not underwent caesarean hysterectomy.

In our study, there was high correlation between surgical and histopathologic findings for placental adherence/invasion.
The presence of placenta previa was present on MRI in 13 (56.5%) pregnant females who underwent hysterectomy and whose histopathologic impression was accreta-increta and percreta, suggesting high concordance of placenta previa with PAS.

The presence of placental heterogeneity was present on MRI in 12 (56.5%) pregnant females who underwent hysterectomy and whose histopathologic findings were accreta-increta and percreta, suggesting high concordance of placental heterogeneity with PAS, which is nonspecific feature on MRI for abnormal placentation.

The presence of T2 dark placental band was present in 10 females, and was classified in placenta accreta-increta spectrum on MRI. 9 out of 10, had difficult placental separation. Histopathological impression was made as follow: 2 were placenta percreta, 4 were placenta accreta and 3 were placenta increta.

There was uterine bulge on MRI in 2 females who underwent caesarean hysterectomy and surgical and histopathologic impression of percreta was made, suggesting high specificity of uterine bulge with placenta percreta.

Only 1 female with histopathologic feature of accreta had uterine bulge on MRI.

The loss of placenta - myometrial interface on MRI was present in 4 pregnant females with difficult separation of placenta and histopathological findings of accreta and increta.

4. Discussion

The present study was retrospective observational study with participants of high risk 23 pregnant female in her 2nd or 3rd trimester that underwent MRI study for placental invasion with primary aim of adding weightage to diagnostic accuracy of PAS by antenatal placental MRI.

Currently, there is one study which has correlated MRI parameters with pathological and surgical outcome of high risk pregnancies.

Specific MRI features of adherent and invasive placentation are as follow, which was considered in current study:

Placenta preavia - is any part of placenta that overlies the internal os of cervix. Low lying placenta is defined as inferior placental edge within 2 cm from the internal os. [1].

Uterine bulge - defined as deviation of uterine serosa from the expected planes which is caused by abnormal bulging of placenta towards adjacent organs with distorted morphology of uterine shape. Widening of lower uterine segment because of myometrial remodelling gives hour-glass appearance as compared to normal inverted pear shape of uterus. Myometrial vascular congestion can mimic as the uterine bulge. [2].

Placental parenchymal heterogeneity- categorized in 3 types: 1. Uniform diffusely inhomogeneous, 2. focally heterogeneous especially nearly surgical scar. 3. Diffusely heterogeneous with bizarre signal changes without normal cotyledons. [3]

T2 dark intraplacental band – defined as irregular variably thick bizarre confluent hypointense bands. They represent fibrin deposition from haemorrhage and infarcts. Thin hypointense septae may be seen in normal placenta. [3].

Interruption of placenta–myometrium interface - focal interruption or diffuse loss of T2 hypointense placenta myometrium interface can be seen in PAS disorders. It is often associated with myometrial thinning. In late gestation, baseline may be difficult to visualize. [4].

Interruption of bladder-serosa interface - focal irregularity or interruption of normal hypointense bladder wall is suspicious for bladder wall involvement. Nodular placental tissue into the bladder wall is diagnostic of placenta percreta. Tenting of bladder is associated with PAS disorders. Vascular flow voids in the bladder wall and serosa or vesical uterine space are also suspicious for bladder wall involvement. Loss of bladder serosa interface is highly specific for placenta percreta. [4].

Placental bulge has been shown to be an independent predictor of myoinvasive severe PAS disorder, with sensitivity of 76.7% and specificity of 62.5% for placenta increta and sensitivity of 77.4% and specificity of 64.7% for placenta percreta. [4].

In our study, 2 pregnant female with radiological impression of placenta percreta due to uterine bulge were finally diagnosed with placenta percreta on intra operative and Histopathological study. In our study specificity for uterine bulge was 100%, likely due to small sample size.

High association was observed between of PAS disorder in current pregnancy with number of previous caesarean delivery (82% in our study) which is in association with previous study done by srisajjakul S et al. [5].

Placenta previa was most common MRI finding associated with high chance of myoinvasion or placental adherence, which is in concordance with previous study [6].

Presence of thick irregular T2 hypointense intraplacental bands was the most sensitive MRI feature for PAS disorders as shown in previous studies [7].

Increasing number and volume of placental bands associated with increased depth of placental involvement in our study. There were certain limitations like, blood vessel and hemorrhage may mimic intraplacentalT2 hypointense bands.

MRI features of extra uterine spread of placental invasion in our study were found to be similar to those of previous study of Bourgioti et al. Increase in extent of placental invasion was associated with need for hysterectomy as well as planning for multidisciplinary surgical approach as supported in previous studies.[8].

5. Limitations

1) We did not perform comparison with ultrasound findings in all patients. Discrepancies existed between clinical and histological diagnosis of invasion in few patients.
2) There was intentional selection of pregnant females who had undergone expert sonography, enhancing chance of detection of MRI findings of placental invasion by meticulous interpretation.

6. Conclusion

Our study shows that various MRI findings suggestive of placental invasion and ability to differentiate placental accreta-increta spectrum from placental percreta, helping the treating obstetrician for better patient counselling and to prepare for intraoperative complication in tertiary care centre with maternal and neonatal intensive care units.

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Table/ figure 1: Patient demographic and clinical history (n=23):

Characteristics	
1.Maternal age (years), mean +/-sd	31 +/- 5
2.Gestational age (weeks) at the time of MRI	26 +/- 3 weeks (mean)
3.previous caesarean /uterine surgery:	
1	12
≥2	7
Previous uterine surgery(Myomectomy or curettage)	4

Table/figure 2: MRI impression of all pregnant females (n=23).

MRI impression	Frequency, n=23
Normal placenta	10
Placenta accreta-increta spectrum	11
Placenta percreta	2

Table/figure 3: Surgical impression (n=23).

| Surgical impression	No hysterectomy	Hysterectomy
Easy separation of placenta	10	0
Difficult separation	0	11
Frank serosal invasion/uterine rupture/urinary bladder invasion	0	2

Table/figure 4: Histopathological impression (n=23).

Histopathologic impression	Frequency
Sample not sent	10
Accreta	7
Increta	4
Percreta	2

Table/figure 5: Frequency of placental MRI findings:

| MRI parameters	Frequency
Placenta previa	13
Placental heterogeneity	12
T2-dark placental band	10
Loss of placenta-myometrial interface	4
Loss of bladder-serosa interface (uterine bulge)	3

(a)   (b)
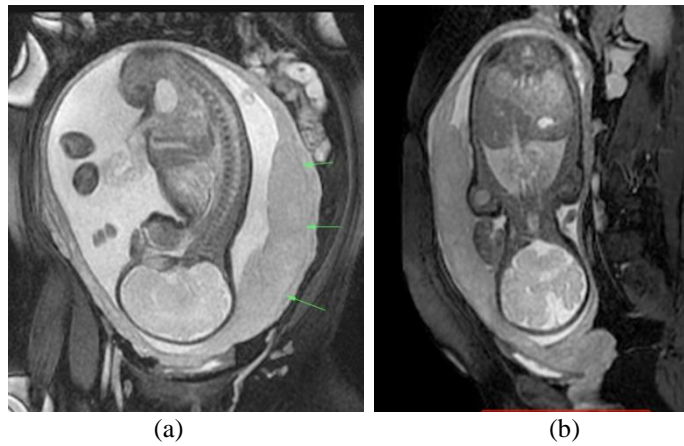
Table/figure 6: Normal appearance of placenta. a, b. Axial and sagittal T2W images of normal placenta obtained at 28 weeks , shows smooth contour and tapering angular edges. Placenta appears uniform in thickness and shows homogeneous signal intensity with thin hypointense internal septae which may represent cotyledons. c. Note normal retroplacental thin hypointense myometrial band (marked as arrow). d. Normal trilaminar appearance is seen at the site of placental implantation.


(a)   (b)

(c)   (d)   (e)
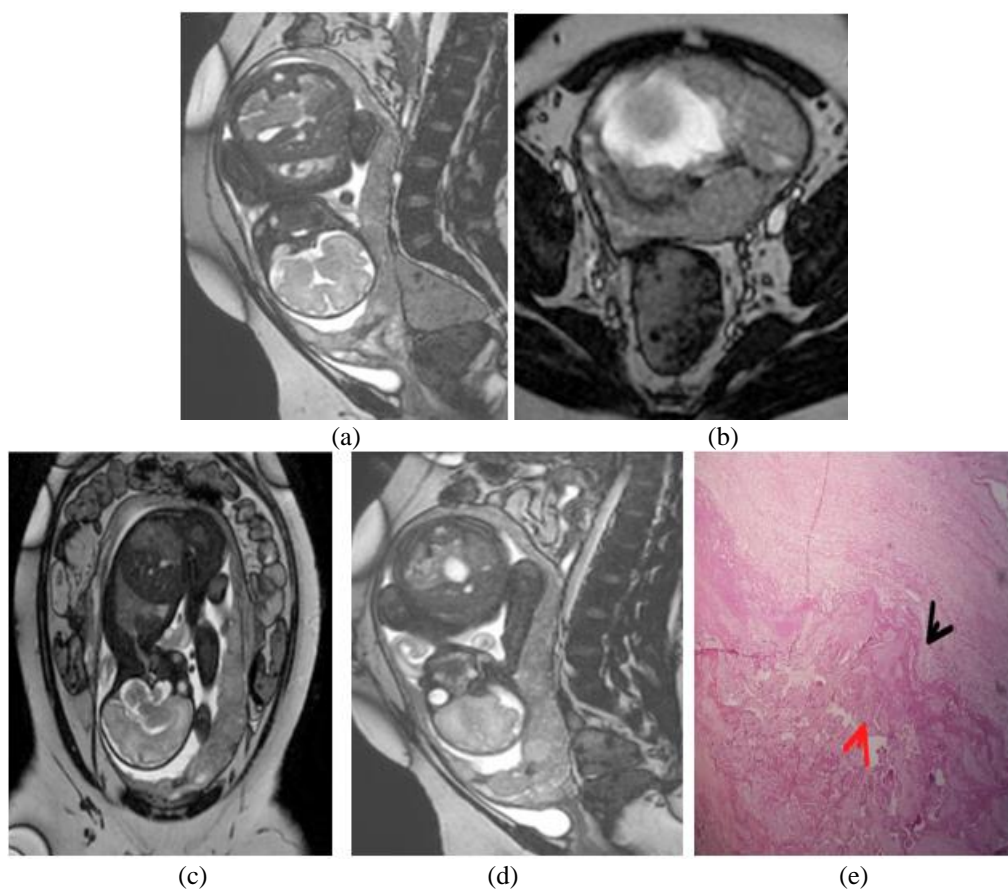
Table/figure 7: 32-year-old pregnant woman with 28 week pregnancy and placenta accreta. **a-e**. Sagittal, axial and coronal T2W images show placenta previa with heterogeneous signal intensity of placenta with irregular intraplacental hypointense bands and loss of retroplacental hypointense band. Pathological examination revealed placenta accreta. Photomicrograph showing placenta accreta with chorionic villi (red arrow) implanting directly on the surface of the myometrium (black arrow) without intervening decidua.

(a)   (b)

(c)   (d)
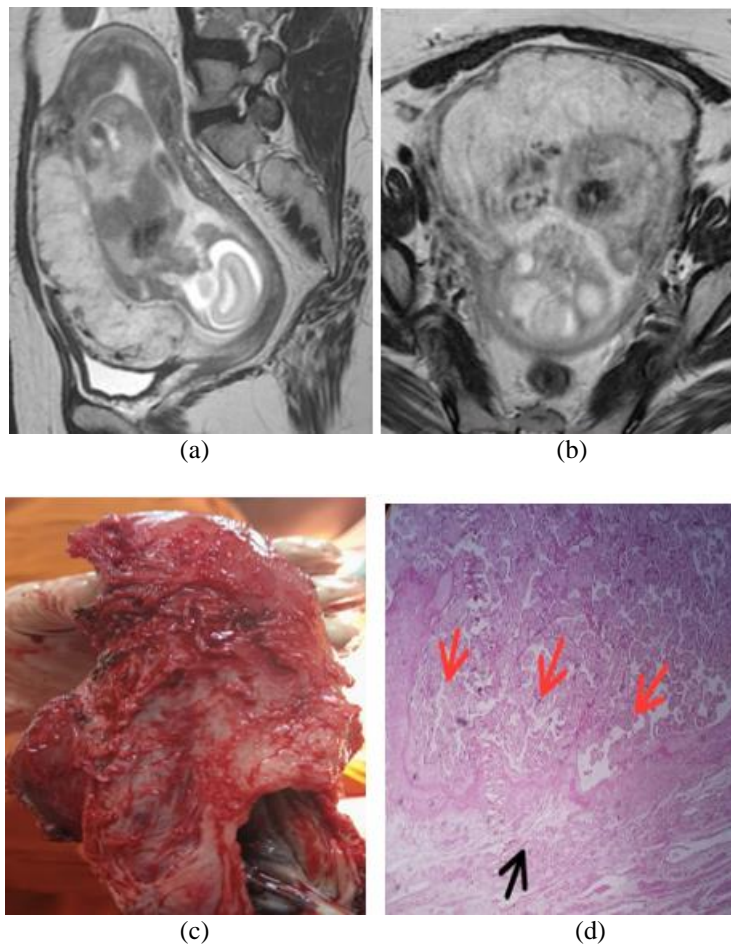
Table/figure 8: a-d. 32-year-old pregnant woman with 22 weeks pregnancy. **a** and **b:** shows bulky heterogeneous placenta with multiple small ill-defined hypointense foci at placental myometrial interface. Loss of retroplacental hypointense band is seen. Focal bulging is seen over anterior surface of lower uterine segment. **c:** shows marked irregularity of outer surface of placenta. **d:** photomicrograph of placenta increta shows chorionic villi (red arrow) invading into the myometrium (black arrow).

(a)   (b)

(c)   (d)
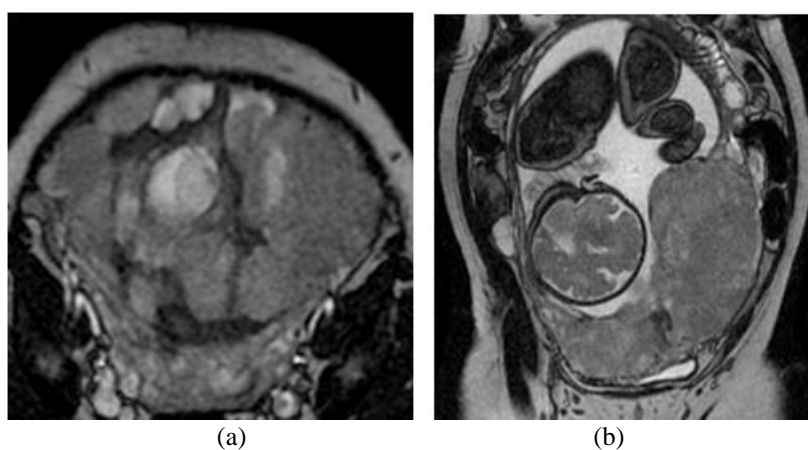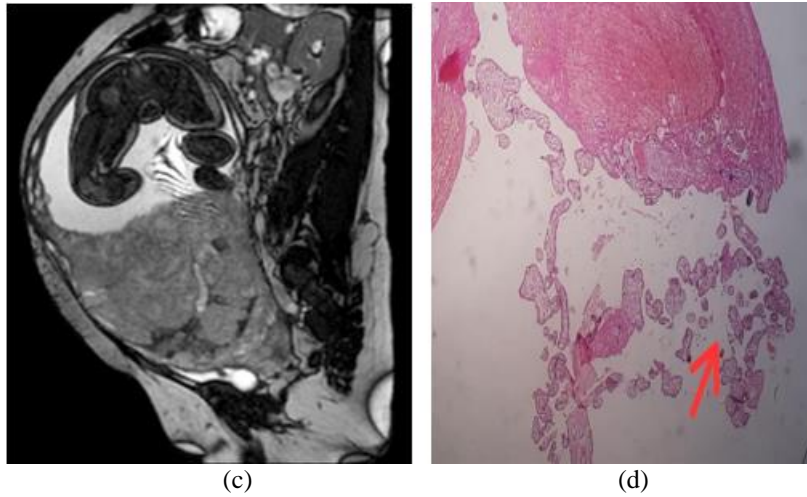
Table/figure 9: a-d: 32-year-old pregnant woman with placenta percreta. MR images obtained at 28 weeks gestation show placenta with heterogeneous signal, lumpy bulging contour, rounded edges and multiple intraplacental T2 hypointense thick bands with disruption of hypointense line at placenta myometrial interface. Interruption of placenta urinary bladder serosa interface with tenting of urinary bladder suggests placenta percreta. Photomicrograph of placenta percreta showing chronic villi (red arrow) invading through uterine serosa with no residual myometrium seen in this area.