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RESEARCH ARTICLE

Magnetic Resonance Imaging in Abnormal Placentation- Emphasis on the Bulge, Breach, Bands, and Blood Vessels

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ABSTRACT

Objective: To estimate the diagnostic ability of magnetic resonance imaging (MRI) for identifying abnormal placentation (AP). **Material and Method:** A retrospective record-based study was performed in our radiology department from April 2014 to 2024. Pregnant women with obstetric MRIs for AP during their third trimesters (24-30 weeks) were included. Patients with limited or suboptimal MRIs and those who were contraindicated were excluded. Histories of the previous caesarian sections and placenta previa were recorded. MRIs were performed on a 1.5T machine. MRI findings of a focal outward contour bulge (B1), a breach (B2) in the placental-myometrial interface, T2 dark intra-placental bands (B3), and increased placental blood vessels (B4) were recorded. MRIs were reported by the consensus of two experienced body radiologists. Operative findings and histopathological reports were taken as the gold standard. MRI findings and AP results were compared using the Fisher's Exact test. **Results:** Out of 110 patients (range: 20-45 years, SD- 7.3, mean age of 32.28 years), 34 had placenta previa. Patients with 2Bs had mostly uneventful placental separations (28/54), while 19 had accreta and 7 increta. Patients with 3Bs mostly had placenta increta (24/35) while those with 4Bs had either placenta increta (3/6) or percreta (3/6). Findings were found significant using Fisher's Exact test (Fisher's exact value = 77.58; P – value = 0.000). **Conclusion:** The combination of specific placental findings on obstetric MRI can help predict the type of abnormal placentation. **Limitations:** Single center, small sample size, and retrospective study.

INTRODUCTION

Placenta accreta spectrum (PAS), also known as morbidly adherent placenta (MAP), abnormally invasive placenta (AIP), or abnormal placentation (AP), is a high-risk pregnancy condition [1,2]. The frequency of PAS has increased due to the increasing number of cesarean deliveries. Normally, childbirth is followed by placental detachment from the uterus. However, in the case of an abnormally implanted placenta, ranging from simple adherence (creta) to a variable (partial or complete) degree of myometrial invasion (increta and percreta), detachment of the placenta becomes difficult and can lead to postpartum hemorrhage [3,4].

In these cases, uterine conservation may not be possible, and caesarian or obstetric hysterectomy may be required to control life-threatening or intractable bleeding [5,6]. Therefore, prompt and early diagnosis of such a condition is vital, and optimal management requires a comprehensive multidisciplinary care team to prevent associated morbidity and mortality [7].

As ultrasound is readily available and inexpensive, it is usually the first imaging choice for the female pelvis, particularly during regular obstetric evaluations [8,9]. However, ultrasound has its limitations, e.g., obscuration by bowel gases, limited scanning window, varied patient build/habitus, and expertise of the technician can impact the results. Magnetic resonance imaging (MRI) is the preferred imaging modality for further investigation of suspicious or equivocal ultrasounds in high-risk cases, and it can be instrumental in diagnosing fetoplacental abnormalities due to its multiplanar acquisition, superior tissue characterization, and high-contrast resolution [10].

Different MRI findings which may indicate the presence of AP, such as heterogeneous placenta, focal outward contour bulging, abnormal placental vascularity and heterogeneity, T2 dark intra-placental bands, myometrial wall interruption, and tenting of the urinary bladder, have been described in the literature [11,12]. Very few studies have highlighted MRI findings for the diagnosis of AP [5,11,12]. Therefore, we aim to evaluate the diagnostic ability of a set of MRI findings to determine the degree or depth of abnormal placentation.

METHOD

A retrospective record-based study was carried out in the radiology department at our hospital in Dhahran by reviewing medical records and MRI scans of women with suspected PAS on ultrasounds. These cases were presented over ten years from April 2014 to April 2024. Pregnant women with MRIs for evaluation of AP during their third trimester were included. Patients with limited (suboptimal) MRIs due to breathing artifacts and those contraindicated (or not possible due to claustrophobia) were excluded. Histories of previous caesarian sections and placenta previa were recorded. All information was kept strictly confidential. The research was conducted per the Helsinki Declaration.

Keeping TR/TE (Time to repeat/ Time to echo) of 652/91.7 ms and flip angle of 0^0 for multiplanar Single-Shot Fast Spin Echo (SS-FSE) and 3.9/1.7 ms and 70^0 for Fast Imaging Employing Steady-state Acquisition (FIESTA) sequences, MRI exam was carried out on a GE (General Electric) HDX 1.5 Tesla scanner machine, using circularly polarized spine array and circularly polarized body array coils. FOV of 61.1 x 37.0 cm was set for both sequences. Patients with limited MRIs and those contraindicated were excluded.

MRI findings of focal outward contour bulge or uterine bulging (disruption of normal pear shape of the uterus), T2 dark intra-placental bands (seen as nodular or linear areas of low signal intensity denoting fibrin deposition), increased placental blood vessels (seen as curvilinear areas of flow voids), breech in the placental-myometrial interface (seen as focal interruptions of placental boundary due to adherence or penetration), and extra-uterine extension (direct invasion to adjacent viscera) were documented. The presence individual or set of Bs (bulge, bands, blood vessels, and breech) was correlated with clinical outcome and operative findings.

Two experienced radiologists with more than 10 years of expertise in body/ MR imaging evaluated the scans and reviewed the findings by mutual consensus. Clinical/ operative findings during cesarean sections and histopathology reports (in cases of hysterectomies) were considered the gold standard for the determination of AP. Clinically, uneventful retrieval of the placenta was considered negative for adherence while difficult manual removal of the placenta and uncontrolled bleeding after placental separation was considered positive for AP.

Data was collected and analyzed using IBM SPSS Statistics for Windows, version 22 (IBM Corp., Armonk, NY, USA). MRI findings and AP results were compared using the Fisher's Exact test.

RESULTS

Out of 110 patients (range: 20-45 years, SD- 7.3, mean age of 32.28 years), 34 had placenta previa. AP was found in 69 patients [Table 1, Fig.1].

Table 1. MRI findings and abnormal placentation

RI (B) Findings	Abnormal placentation per operative findings		Total
	Present	Not Present	
1	0	15 (36.6)	15
2	31 (44.9)	23 (56.1)	54
3	32 (46.4)	3 (7.3)	35
4	6 (8.7)	0	6
Total	69	41	110

Fisher's Exact = 44.88; P – value = 0.000

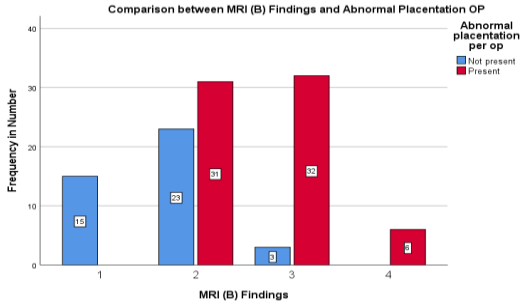

Fig. 1. Frequency bar chart showing MRI findings and AP.

Patients with 2Bs had mostly uneventful placental separations (28/54), while 19 had accreta and 7 increta. Patients with 3Bs mostly had mostly placenta increta (24/35) while those with 4Bs had either placenta increta (3/6) or percreta (3/6). Findings were found significant Fisher's Exact = 77.58; P – value = 0.000) [Table 2, Fig. 2].

Table 2. MRI findings and type of abnormalities detected

MRI (B) Findings	Type of Abnormality				Total
	Accreta	Increta	Percreta	Uneventful	
1	0	0	0	15 (33.3)	15
2	19 (67.9)	7 (20.6)	0	28 (62.2)	54
3	9 (32.1)	24 (70.6)	0	2 (4.4)	35
4	0	3 (8.8)	3 (100)	0	6
Total	28	34	3	45	110

Fisher's Exact = 77.58; P – value = 0.000

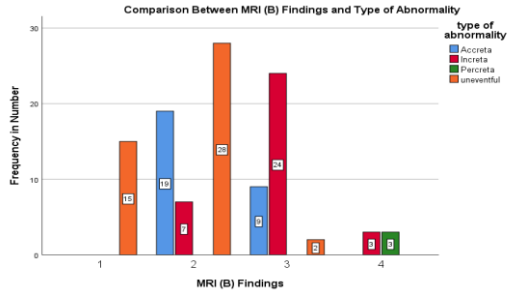

Fig. 2. Frequency bar chart showing MRI findings and types of AP.

Correlation of specific Bs (bulge, bands, blood vessels, and breech) on MRIs and outcomes (types of AP) were found significant [Fig.3].

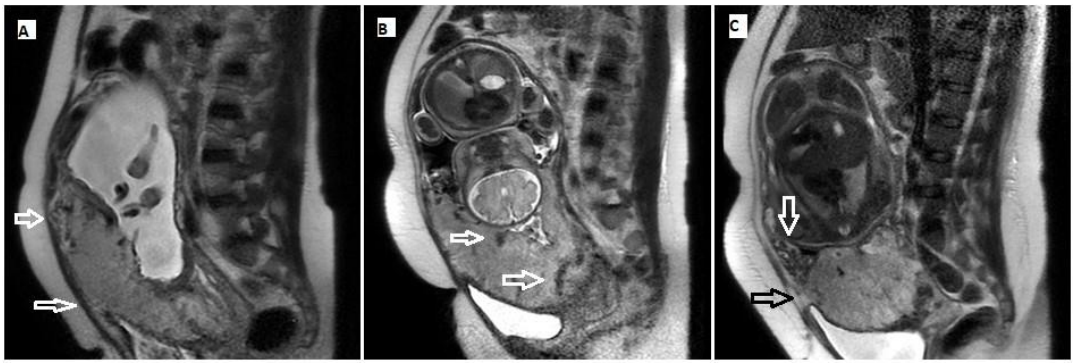

Fig. 3. Selected sagittal MRI images of different patients with evidence of abnormal placentation demonstrated focal myometrial bulging and loss of placental-myometrial interface or breach (arrows in image A), intra-placental T2 dark bands (arrows in image B), increased blood vessels (vertical arrow pointing below) and loss of outer wall or invasion (horizontal arrow).

DISCUSSION

If unrecognized prior to delivery, abnormal placentation can lead to catastrophic perinatal hemorrhage. Sonography is the primary diagnostic screening tool for fetoplacental assessment until the 20th week of gestation [8]. When ultrasound evaluation is equivocal or patients are at high risk for AP, MRI is indicated for further evaluation [10]. Accurate identification of affected pregnancies allows for optimal and comprehensive perinatal obstetric management. Our study highlighted important clinical implications for the diagnosis of AP.

Placenta previa has been documented as a risk factor for abnormal placentation. Most of our patients with increta and percreta were found to have 2 or more than 2 C-sections and placenta previa. These risk factors have also been observed in previous studies [13,14], in addition to increasing maternal age [15]. Any type of uterine surgery can damage the myometrium, which may then be invaded by placental tissue in subsequent pregnancies. The pathophysiology is thinning of the myometrium and its replacement by scar tissue, which provides more room for placental adherence and a weaker barrier to placental penetration or invasion.

Second, we found that certain MRI findings (like 3Bs and 4Bs) were more sensitive in identifying increta and percreta i.e., depth of invasion, and thereby predicting AP correctly. Familiari et al. showed the variable but high sensitivity of MRI (85%–100%), with fluctuating degrees of placental implantation, in an evaluation of MR studies of suspected AP in 1080 pregnant women requiring MRI [16]. Similarly, Wang et al. observed higher diagnostic values of MRI while reviewing 168 patients with suspected placenta previa and found that MRI findings were also helpful for detailed treatment planning [17]. Maurea et al. devised a methodology for correctly identifying AP in 61 patients. They found that the presence of at least 2 (out of 6) described findings among all abnormal MRI signs represented the most accurate criterion for identifying AP, although they combined any 2 findings, rather than determining accuracy on the basis of a specific set of findings [18]. Valentini et al. observed comparable results from at least 2 specific signs in a review of MRI findings in 27 women with suspected MAP [19]. In our study, we only considered MRI findings, either individually or in certain combinations (4 Bs; Bulge, Breach, Bands, Blood vessels), to identify the detection rate and accuracy in AP. However, devising an imaging scoring system or combining clinical and ultrasound findings may offer more comprehensive and reliable management of AP patients. Knight et al. combined the scoring system of both ultrasound and MRI and found these to be more sensitive and accurate for correctly identifying MAP [20]. We did not include MRI studies involving intravenous gadolinium. Millischer et al.

used contrast injections in 20 women with prior C-sections and placenta previa who had given consent and found improved results compared to non-contrast examinations [21].

Our study showed that myometrium thinning due to placental bulging was weakly associated with AP. Srisajjakul et al. revealed that these findings may be present in normal placentas, leading to false positive results if considered in isolation [22]. This contradicts Othman et al., who found that myometrium thinning was the most significant predictor for AP [12]. Their data also showed that loss of the retroplacental zone suggesting myometrium invasion had 93% specificity and 95% accuracy. Placenta percreta penetrates the uterus and can invade adjacent pelvic structures, including the urinary bladder, lower rectus sheath, parametrium, and lateral pelvic wall. If identified via MRI, these signs of invasion can precisely indicate morbid adherence to the placenta. Two false positive cases indicating loss of the retroplacental zone and focal myometrial interruption, along with the detection of abnormal vessels, were related to MRI findings. Imaging pitfalls were highlighted by Srisajjakul et al. and Othman et al. as imaging errors related to the concentration of blood vessels near the umbilical attachment and the increase in blood vessels toward the end of the gestation period [12, 22].

The limitations of our study included its retrospective nature, single-center results, and small sample size. Intravenous contrast was not used for MRI studies, which may have identified the presence of abnormal vessels more clearly. In addition, the sensitivity of the MRI findings was not compared with the depth of placental invasion. Future prospective multi-center studies are needed using a combined clinical and ultrasound scoring system that incorporates MRI findings to validate these results.

CONCLUSION

The combination of specific set placental findings on obstetric MRI can help predict the type of abnormal placentation.

AUTHORS' CONTRIBUTION

KBW conceived the idea, conception of design, and manuscript editing
SS contributed to manuscript writing and literature review
MZH participated in manuscript editing and review
AAGA made critical appraisal
LDA assisted in data collection and analysis
SAA contributed to drafting of article
WN helped in critical analysis and literature review
AH assisted in data review
JHM helped in data analysis
ZB helped in data entry and coding
ZJK did statistical analysis

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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