

Role of Ultrasound and Magnetic Resonance in Evaluation of Placenta Accreta

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ABSTRACT

Background: Placenta accreta (PA) is one of the most dangerous conditions of pregnancy. It occurs when there is an abnormal adherence of a part or entire of the placenta to the uterine wall with either partial or complete absence of the decidua basalis. The placenta may be abnormally adherent to the myometrium, or extend to invade other tissues (uterine serosa or urinary bladder). **Objective:** This study aimed to assess the effectiveness of MRI and ultrasound for diagnosing placental accretion during pregnancy.

Methods: Forty-seven pregnant patients with persistent placenta previa (after 28 weeks) and ultrasound findings suggestive of possible accreta were included in this prospective study. By contrasting their findings with the surgical outcomes after Cesarean section, the diagnostic accuracy of MRI and ultrasound in identifying placental accreta was assessed.

Results: The study included patients aged between 20 and 44 years, with a mean age of 32. The mean gestational age was 33 weeks, ranging from 33 to 36 weeks. The average parity on a 1-5 scale was 3.06 ± 1.19 . When it came to diagnosing placenta accreta, greyscale and color Doppler ultrasound showed 100% sensitivity, 72% specificity, and 89% accuracy. With 91% sensitivity, 83% specificity, and 89% accuracy, MRI also demonstrated value in the diagnosis of accreta, particularly when the ultrasound results were inconclusive or the placenta was posterior.

Conclusion: While MRI is used when ultrasound lacks sufficient clarity or as a second opinion for ambiguous findings, particularly with posterior placenta, ultrasound remains the first choice for screening placental invasion.

Keywords: Magnetic resonance imaging, Color Doppler, Ultrasound, Placenta accreta.

INTRODUCTION

A major cause of obstetric hemorrhage and a potentially fatal pregnancy condition, placenta accreta is linked to heightened maternal morbidity and mortality. Prenatal diagnosis, when performed early, tends to lead to better results for both the mother and newborn. The incidence of placenta accreta has risen significantly in the past 30 years, alongside a rise in Cesarean deliveries ⁽¹⁻²⁾.

Placenta accreta and its severe complications, including severe postpartum bleeding, coagulopathy, Cesarean hysterectomy, and even death, are more likely to occur in patients with a history of Cesarean section and placenta previa ⁽³⁾.

Early diagnosis of placenta accreta in utero is crucial for providing the necessary care and precautions. It is more likely in patients with risk factors like being over 35, having placenta previa, a history of Cesarean sections, uterine anomalies, previous uterine surgeries, dilation and curettage, myomectomy, and high parity ⁽⁴⁻⁵⁾.

Although color Doppler studies and greyscale ultrasound are typically used for initial diagnosis, MRI can be used in cases where ultrasound is unable to provide a definitive diagnosis ⁽⁶⁾. Additionally, because grayscale ultrasound is accurate and requires little time or money, MRI cannot be used as a screening tool ⁽⁷⁾.

PATIENTS AND METHODS

The study was conducted prospectively through the period from July 2021 to April 2022, included 47 pregnant patients aged 25 to 40 years, with a mean age of 32. These patients, who were diagnosed with persistent placenta

previa after 28 weeks and had ultrasound results suggesting possible accreta, were admitted to Menoufia University Hospital's Obstetrics and Gynecology Department.

Inclusion criteria: Pregnant women with implantation of the placenta on the lower uterine segment, vaginal bleeding, and a preliminary US finding suggestive of placental accretion.

Exclusion criteria: Patients with cardiac implanted electronic devices, cochlear implants, metallic splinters or vascular clips, metallic hip replacements that were incompatible with MRI, and those who were unable to lie still during the scan because of a related medical condition.

Using a 5-7-MHz trans-abdominal transducer (GE logic E10) with a distended bladder, ultrasound was performed following history taking and clinical examination to improve visualization of the serosa-bladder interface. Grayscale and color Doppler ultrasound images of the placenta were obtained with the insonation angle as low as feasible.

Placenta accreta and its variations (placenta increta and placenta percreta) are primarily identified by the features found on grayscale ultrasound imaging, such as focal exophytic masses invading the bladder, interruption or thinning of the hyperechoic uterine serosa-bladder interface, abnormal placental lacunae, and complete loss or irregularity of the retroplacental sonolucent zone. For prompt intervention and efficient treatment, placental

invasion must be identified and diagnosed early, which is made possible by these ultrasonography indicators.

Sonolucent vascular lakes with turbulent flow and high velocity (peak systolic velocity >15 cm/s), diffuse or focal lacunar flow, hypervascularity at the uterine-bladder interface with abnormal blood vessel connections to the bladder, and significantly dilated vessels in the peripheral subplacental area are all highly suggestive of placenta accreta according to color Doppler findings. These results are vital for early detection of placental invasion, which helps with the right clinical treatment to reduce the risk of serious consequences like bleeding and hysterectomy. A 1.5-Testa unit (TOSHIBA, Vantage) equipped with an eight-channel phased-array body coil was used for the MRI examination. In order to lower the possibility of uterine compression resulting in impaired venous return, third-trimester patients were placed in the left lateral decubitus position. Balanced fast field echo (B-FFE), T2-weighted fast spin echo (FSE), T1-weighted spin echo (SE), and T2 Single Shot spin echo (SSh-SE) sequences were used to perform the mother's pelvic MRI imaging. Every sequence was carried out with a 90° flip angle, 5–6 mm slice thickness, and 1 mm between slices.

Respiratory triggering was used in sequences (1) and (2) to minimize motion artifacts. The entire scan took about thirty-two minutes, and no intravenous contrast was used. If any of the following MRI findings were seen,

placenta accreta was diagnosed: focal disruptions, uterine bulging, and variable signal intensity within the placenta.

The diagnostic performance of ultrasound and MRI in identifying placental accreta was measured by comparing the results of these imaging techniques with surgical data obtained during Cesarean section. At our hospital, all pregnancies included in this study were delivered via Cesarean section, and all delivery details were fully available. When the placenta was observed invading the myometrium during delivery, placenta accrete was definitively diagnosed.

Ethical approval: Prior to the commencement of the study, each participant completed a written consent and the research was authorized by Menoufia Faculty of Medicine’s Local Ethical Research Committee. According to Helsinki. Additionally, the Institutional Review Board was obtained under code no. [9/2021RAD27].

RESULTS

The following table showed the diagnostic value of ultrasound findings for detection of placental accretion. The most accurate US finding was placental lacunae (100% accuracy) followed by irregular retroplacental space (81% accuracy), while the least accurate US finding was exophytic mass invading UB (32 % accuracy) (Table 1).

Table 1: Role of ultrasound in diagnosing placental accreta

US findings	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)
Total absence of the retroplacental zone	94	41	62	50	92
Irregular RPS	100	81	94	91	100
Thinning of seroso-bladder interface	100	52	74	65	100
Placental lacunae	100	100	100	100	100
Exophytic mass invading UB	100	29	32	6	100

PPV: Rate of true positives, NPV: Rate of true negatives.

Table (2) illustrated the contribution of Doppler ultrasound results in diagnosis of placenta accreta. The most accurate Doppler finding was turbulent vascular lakes (100% accuracy) followed by hypervascular serosobladder interface (81% accuracy), while the least accurate Doppler finding was marked dilated VS on subplacental region (60% accuracy).

Table (2): Role of Doppler ultrasound findings in diagnosing placenta accreta

Doppler US findings	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)
Turbulent vascular lakes	100	100	100	100	100
Diffuse lacunal flow pattern	72	25	68	91	8
Hyper vascular serosobadder interface	96	60	81	76	92
Marked dilated VS on subplacental region	100	41	60	44	100

PPV: Rate of true positives, NPV: Rate of true negatives

Table (3) highlighted the role of MRI findings in diagnosing placenta accreta. The most accurate MRI finding was heterogenous signal intensity within the placenta (91% accuracy) followed by uterine bulging (89% accuracy), while the least accurate MRI finding was tenting of the UB (59.6% accuracy).

Table (3): Diagnostic value of MRI findings for detection of placenta accreta

MRI findings	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)
Uterine bulging	94	77	89	91	83
Heterogenous signal intensity within the placenta	97	77	91	92	91
Focal interruption of the myometrial wall	94	69	87	89	82
Dark intra-placental bands	85.3	61.5	78.7	85.3	61.5
Tenting of the UB	61.8	53.9	59.6	77.8	35

PPV: Rate of true positives, NPV: Rate of true negatives.

Table (4) showed the diagnostic accuracy of final ultrasound for detection of placenta accreta where sensitivity, specificity, accuracy, PPV and NPV were 100%, 72%, 89%, 85% and 100% respectively.

Table (4): Diagnostic value of final ultrasound for detection of placental accretion

Final diagnosis	Ultrasound				Test of significance	p-value
	Positive (n=29)		Negative (n=18)			
	No.	%	No.	%		
Positive (n=34)	29	100	5	27.8	FE=28.95	<0.001*
Negative (n=13)	0	0	13	72.2		
Sensitivity (%)	100					
Specificity (%)	72					
Accuracy (%)	89					
PPV (%)	85					
NPV (%)	100					

*: Statistically significant, FE: Fisher exact test, PPV: Rate of true positives, NPV: Rate of true negatives.

The following table shows Diagnostic value of final Doppler US for detection of placental accretion. The diagnostic accuracy of final Doppler ultrasound where sensitivity, specificity, accuracy, PPV, NPV were 100%, 72%, 89%, 85%, 100% respectively (Table 5).

Table (5): Diagnostic value of final Doppler US for detection of placenta accreta

Final diagnosis	Doppler ultrasound				Test of significance	p-value
	Positive (n=29)		Negative (n=18)			
	No.	%	No.	%		
Positive (n=34)	29	100	5	27.8	FE=28.95	<0.001*
Negative (n=13)	0	0	13	72.2		
Sensitivity (%)	100					
Specificity (%)	72					
Accuracy (%)	89					
PPV (%)	85					
NPV (%)	100					

*: Statistically significant, FE: Fisher exact test, PPV: Rate of true positives, NPV: Rate of true negatives.

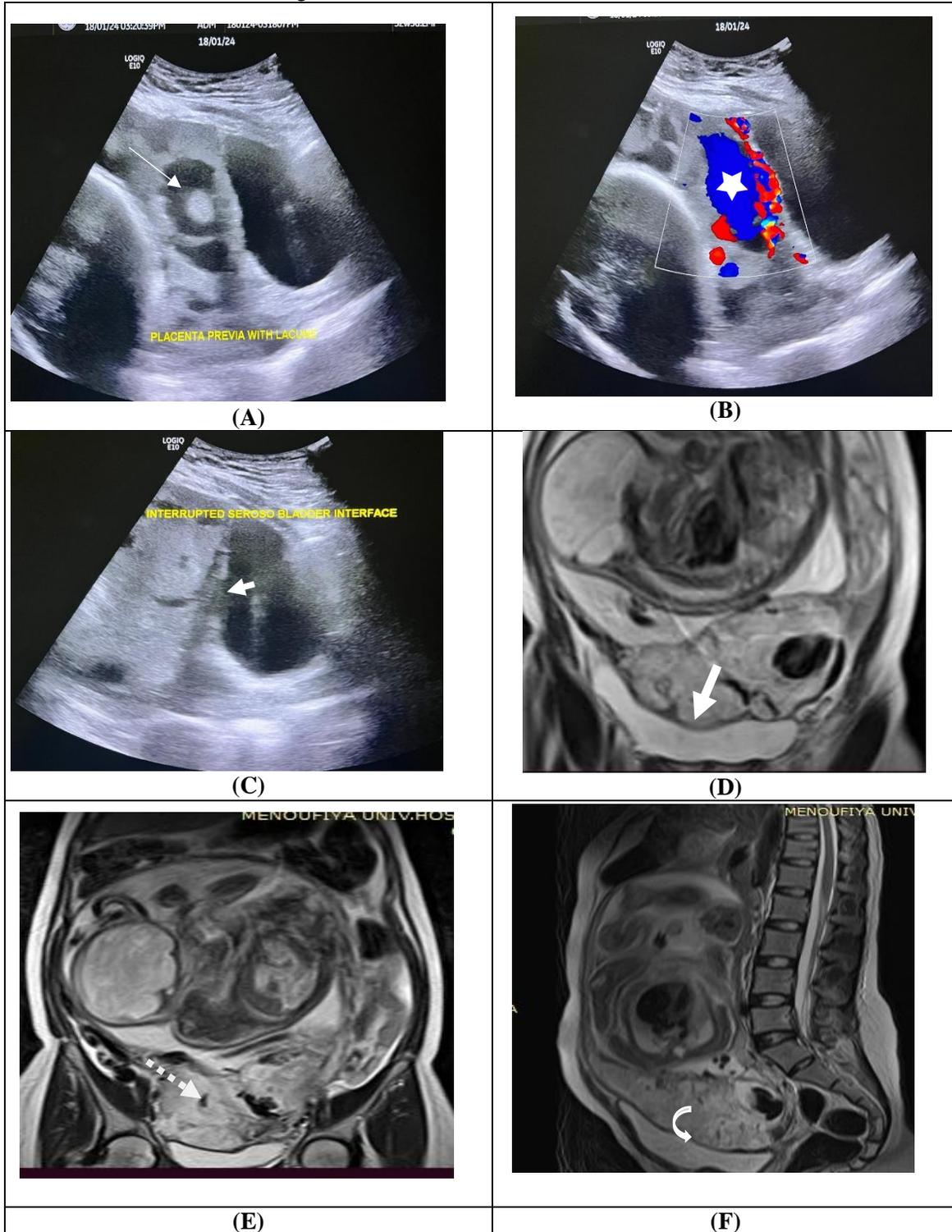
The table below summarized the diagnostic performance of the final MRI for the detection of placenta accreta where sensitivity, specificity, accuracy, PPV and NPV were 91%, 83%, 89%, 94% and 77% respectively (Table 6).

Table (6): Diagnostic value of final MRI for detection of placenta accreta

Final diagnosis	MRI				Test of significance	p-value
	Positive (n=35)		Negative (n=12)			
	No.	%	No.	%		
Positive (n=34)	32	91.4	2	16.7	FE=24.96	<0.001*
Negative (n=13)	3	8.6	10	83.3		
Sensitivity (%)	91					
Specificity (%)	83					
Accuracy (%)	89					
PPV (%)	94					
NPV (%)	77					

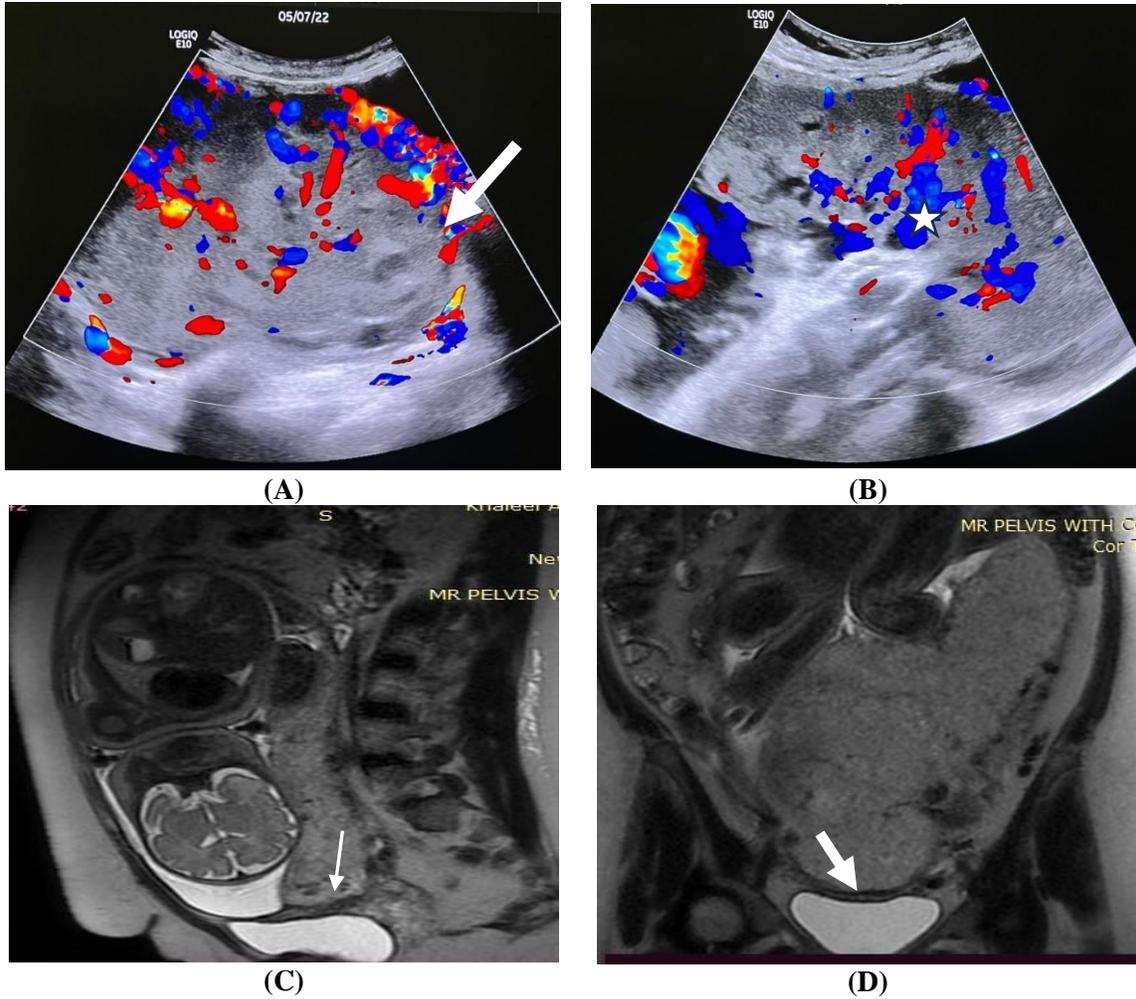
*: Statistically significant, FE: Fisher exact test, PPV: Rate of true positives, NPV: Rate of true negatives.

Figure (1) showed 34-year-old woman who is 35 weeks pregnant, had three previous Cesarean sections, and had one D & C after an abortion. She also exhibited vaginal bleeding. Multiple irregular placental lacunae (white arrow) and a thinned interrupted seroso-bladder interface (short arrow) (Figures. A, B, and C sagittal US and Doppler. Color Doppler (B) displayed a turbulent color flow of the lacunae (star). In figures D, E, and F, coronal and sagittal T2 MRI scans revealed a thickened and heterogeneous placenta, along with uterine bulging in the lower uterine segment (broad arrow), which modifies the normal pear-shaped appearance of the pregnant uterus. The dotted arrow showed a dark intraplacental band, and the curved arrow indicated a thinning bladder- uterine serosa interface.



(Fig 1)

Figure (2) showed a female patient 32 years old pregnant (33 weeks pregnant) with 2 previous C.S and 2 abortions, presented by vaginal bleeding. Figure A and B sagittal Color Doppler US that showed placenta previa complete centralis with hypervascular seroso-bladder interface (A) (broad arrow) and turbulent colour flow within placental lacunae (B) (star). Figure (C & D) Sagittal, and coronal MRI T2-weighted FSE that showed placenta previa complete centralis with dark intraplacental bands (lacunae) (thin arrow) and uterine bulge (short arrow).



(Fig 2)

DISCUSSION

In this study, we looked at 47 patients who had irregular vaginal bleeding during the third trimester. US and MRI scans were performed on the patients to determine whether placenta accreta was present. According to our research, the participants' average age was 32.17 years, and their average parity was 3. **Garmi and Salim** ⁽⁸⁾ reported a median maternal age of approximately 34 years and a mean parity of 2.5, which is consistent with our findings. 33.2 weeks was the average gestational age in our study. Furthermore, we found that 72% of cases had one to four prior Cesarean sections (mean of three), indicating that the risk of placenta accreta rose with the number of Cesarean sections. This confirms with **Shepherd et al.** ⁽⁹⁾ who found that having a history of multiple Cesarean sections increases the risk of placenta accreta.

In examined placenta accrete cases, the incidence of hysterectomy was 21.3%. **Pan et al.** ⁽¹⁰⁾ reported that 78% of conservative management involved uterine arterial embolization, and 25% involved primary or delayed hysterectomy. Ours is consistent with their findings. Placental lacunae have a high predictive value, our study demonstrated that they had the best sensitivity, specificity, PPV, and NPV, all of which were 100%. In the 15–40-week gestational age range, **Comstock et al.** ⁽¹¹⁾ demonstrated a high sensitivity of 93%, which is consistent with ours.

Our analysis revealed that the US had 100%, 81%, 94%, 91%, and 100% for sensitivity, specificity, accuracy, PPV, and NPV for the irregular retroplacental space. This is consistent with **Maged et al.** ⁽¹²⁾ who demonstrated that irregular retroplacental clear space had 87.3%, 89.19%, 93.2%, 80.49%, and 88% for sensitivity, specificity, PPV, NPV, and accuracy respectively in diagnosing placenta accreta.

Using a sensitivity of 100%, specificity of 72%, accuracy of 89%, PPV of 85%, and NPV of 100%, our study demonstrated that ultrasound (US) possessed a strong diagnostic ability for detecting placenta accreta. Sensitivity, specificity, and predictive values of 91.84%, 87.27%, 86.54%, and 92.31% respectively, were reported by **Marsoosi et al.** ⁽¹³⁾ who developed a scoring system to evaluate the risk of placenta accreta.

The importance of color Doppler in identifying placenta accreta was highlighted by our study. Nine out of ten cases had a diffuse lacunar flow pattern, seventy-two percent had turbulent vascular lakes, and fifty-seven percent had a hypervascular seroso-bladder interface. These findings align with those of **Chou et al.** ⁽¹⁴⁾ who determined that the main Doppler indicators were widespread lacunar flow within the placenta, irregular sonolucent vascular lakes with turbulent flow, and hypervascularity with aberrant blood vessels connecting the placenta to the bladder. The high diagnostic value of

Doppler in diagnosing placenta accreta with 100% sensitivity was also demonstrated by our study. This is consistent with the Doppler sensitivity of roughly 97% reported by **Shih et al.** ⁽¹⁵⁾.

In evaluating the diagnostic potential of the hypervascular seroso-bladder interface, our study found sensitivity of 96%, specificity of 60%, accuracy of 81%, PPV of 76%, and NPV of 92% for diagnosing placenta accreta. These results surpass the findings of **Maged et al.** ⁽¹²⁾ who indicated sensitivity, specificity, accuracy, PPV, and NPV of 47.62%, 94.59%, 65%, 51.47%, and 93% respectively for the hypervascular uterine-bladder interface.

With focal interruption of the myometrial wall and bulging of the lower uterine segment observed in the majority of surgically confirmed cases (74.5%), our study's results offered important new information about the features of placenta accreta. Dark intraplacental bands on T2 sequences (72.3%) and aberrant heterogeneous signal intensity within the placenta (76.6%) further bolster the diagnostic value of these imaging characteristics. These results align closely with the work of **Lax et al.** ⁽¹⁶⁾ suggesting that these MRI characteristics can be reliable indicators for diagnosing placenta accreta, potentially aiding in early detection and improving patient outcomes. While our study's findings are generally consistent with those of **Lax et al.** ⁽¹⁶⁾, it is important to note the differences reported by **Hashem et al.** ⁽¹⁷⁾. Similar to our findings, they found dark intraplacental bands on T2 sequences in 72% of cases, but only 48% of cases showed lower uterine segment bulging, which is lower than our observed rate of 74.5%. However, **Hashem et al.** ⁽¹⁷⁾ agree with our study in identifying abnormal heterogeneous signal intensity within the placenta as the most common sign, observed in 80% of cases. These variations in results may reflect differences in study populations, imaging protocols, or diagnostic criteria, but all highlight the importance of MRI in detecting placenta accreta.

When it came to MRI results, we found that the placenta's heterogeneous signal intensities had the highest sensitivity and specificity (97% and 77%), followed by the uterine bulge (94%, 77%, and 89%, respectively). These results are consistent with those of **Thiravit et al.** ⁽¹⁸⁾ who discovered that the placental bulge exhibited the highest accuracy (90.3%), with a sensitivity of 94.4% and a specificity of 84.6%. By contrast, **Riteau et al.** ⁽¹⁹⁾ discovered that myometrial wall focal interruption had low specificity (13%), but good sensitivity (93%). Although our study's specificity was comparatively higher at 69%, the sensitivity was comparable at 94%.

The results from our study demonstrated a relatively high sensitivity and positive predictive value (85.3%), suggesting that T2-weighted MRI is a reliable tool for detecting dark intraplacental bands in many cases.

However, the lower specificity and negative predictive value (61.5%) indicate that false positives may occur, which could be due to differences in study populations, imaging protocols, or the complexity of interpreting MRI findings. The comparison with the findings of **Riteau et al.** ⁽¹⁹⁾ highlights the variability in results, underlining the need for standardization in imaging techniques and a clearer understanding of the factors contributing to these discrepancies. In line with **Meng et al.** ⁽²⁰⁾, who reported 88% specificity for MRI, our study revealed an overall specificity of 83% for MRI.

CONCLUSION

Our research showed how useful MRI and ultrasound are for identifying and assessing the severity of placenta accreta. The main imaging method for detecting placental invasion was ultrasound. MRI is useful when ultrasound is insufficient or as a backup method to confirm ambiguous results, especially when the placenta is located posteriorly.

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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