

Role of doppler ultrasound in comparison with MRI in diagnosis of placental adhesive disorders

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Abstract

Background: Placenta accreta has now become an important etiology of maternal morbidity and mortality. Owing to the increasing rate of Cesarean delivery, there has been a 10-fold rise in the incidence of placenta accreta since the 1970s.

Objectives: to emphasize the diagnostic value of different imaging modalities (Doppler US and MRI) as noninvasive methods in diagnosis of adhesive placental abnormalities.

Patients and methods: A prospective study, conducted in Qena university hospital, South Valley University, Qena, Egypt. The study was conducted on 20 pregnant women has presented with adhesive placental disorders to diagnostic radiology department. All included pregnant female will be subjected to history taking and clinical provisional examination. They will undergo doppler ultrasonography and MRI.

Results: Sensitivity, specificity, accuracy of US was 72.7, 77.8, 75 respectively. But sensitivity, specificity, accuracy of MRI was 100,100,100 respectively.

Conclusion: Magnetic resonance imaging is better than Doppler ultrasound study for the accurate diagnosis of placenta adherence/ invasion.

Key words: placenta, invasion, doppler ultrasonography, MRI

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Introduction

The placenta is an organ that develops during pregnancy in the uterus. It receives attention only when an abnormality is detected. Abnormalities of the placenta are important to recognize owing to the potential for maternal and fetal morbidity and mortality (**Hashem et al., 2016**).

Although statistically a rare complication, placenta accreta has now become an important etiology of maternal morbidity and mortality. Owing to the increasing rate of cesarean delivery, there has been a 10-fold rise in the incidence of placenta accreta since 1970s (**El Wakeel et al., 2018**).

Antepartum imaging should be performed with minimal risk to both the mother and developing fetus. Therefore, noninvasive techniques that do not use ionizing radiation such as ultrasonography (US) and magnetic resonance (MR) imaging are preferred (**Elsayes et al., 2009**).

Ultrasonography is the first imaging modality for evaluation of the placenta in the antepartum period. Color and power Doppler techniques permit visualization of placental vascularity, allowing direct assessment of both the uteroplacental and fetoplacental circulations (**Baert et al., 2013**).

MRI has many unique properties that make it well-suited for imaging of the placenta and is the other dominant imaging modality in the antepartum period (**Hashem et al., 2016**). The aim of our study to emphasize the diagnostic value of different imaging modalities (Doppler US and MRI) as noninvasive methods in diagnosis of adhesive placental abnormalities.

Patient and Methods

Type of the study: Observational prospective cross sectional study.

Study Setting: Qena university hospital, south valley university, Qena, Egypt.

Study subjects: 20 pregnant women has presented with adhesive placental disorders to diagnostic radiology department.

a. Inclusion criteria:

- Pregnant female in the third trimester.
- At least one previous caesarean section.

b. Exclusion criteria:

- Patient with electric and electronic devices.
- Patient with heart pacemakers (especially older types).
- Patient with insulin pump.
- Patient with implanted hearing aid.
- Patient with neurostimulators.
- Patient with intracranial metal clips.
- Patient with metallic bodies in the eye.

Methods

All targeted pregnant female will be subjected to history taking and clinical provisional examination.

They will undergo doppler ultrasonography and MRI.

Prospective analysis with Doppler US and MRI will be done.

A-Pelvic Doppler ultrasonography: (GE , LOGIC P6) with 3.5 MHz probe curved electronic array transducer, ayscale B-mode ultrasonography was first used to assess the placental tissue localization and shape followed by assessment by superimposing color/power doppler over suspected and potential regions of interest.

B-MRI of the pelvis. MRI will be done by Philips Achieva 1.5 Tesla MRI system. The patient should do the examination during full breathing without any sedation and should be with partially full bladder and in the supine position .The procedure is carefully

explained to the mother and it is ascertained that the patient is well fed before the procedure. If not, the mother is given 100-200mL oral glucose to reduce maternal anxiety and fetal motion during the scan. The entire examination time is 20-25min with the following protocol:

Axial, sagittal and coronal T1&T2. Then follow up the results of caesarean sections to compare them with the results of Doppler and MRI of the real status of the placenta of the examined patients.

Statistical analysis

Data were verified, coded by the researcher and analyzed using IBM-SPSS 23.0. Descriptive statistics: Means, standard deviations, medians, ranges and percentages were calculated. Test of significances: chi-square test was used to compare the difference in distribution of frequencies among different groups. For continuous variables; ANOVA analysis was carried out to compare the means of dichotomous data. A significant p-value was considered when it is equal or less than 0.05. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI and ultrasonography indices were calculated.

Results

There were statistical difference by US between the placenta accreta, increta, percreta and non invasion cases concerning abnormal clear space (P value=0.000), loss of bladder uterine interface (P value=0.006), decreased myometrium thickness (P value=0.000), (**Table.1**)

Cases diagnosed of having invasion as reported by caesarean delivery data were 55% (n = 11/20). Cases proved of having just placenta previa with no invasion were 9

cases. US had suggested true-positive diagnosis of invasion in 72.7% (n = 8/11). (**Fig. 1, Fig.2, Fig. 3**)

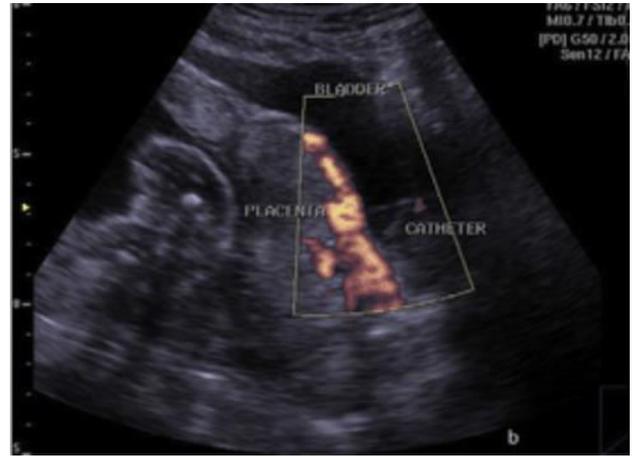


Fig.1. Placenta accreta in 30 year old pregnant female patient at 28 weeks of gestation, was known to have placenta previa during routine antenatal examination with history of previous 5 C.S. Power Doppler shows heterogenous placenta, loss of retroplacental clear space, increased vascularity of the interface & decreased myometrial thickness. Patient was found to have placenta percreta at delivery.

By US 10 cases from 20 cases were diagnosed to have placental invasion and the other 10 cases were diagnosed as placenta previa with no placental invasion.

Matching between US and caesarean delivery result of the positive cases of invasion, US had diagnosed 8 cases of the 11 cases which proved to have invasion correctly after delivery. US had underestimated the degree of invasion in 3 cases (2 cases had underestimated as accreta instead of percreta and one case had underestimated as increta instead of percreta). On the other hand, US had overestimated 2 cases(a case had overestimated as percreta instead of increta while the other case had overestimated as increta instead of accreta).

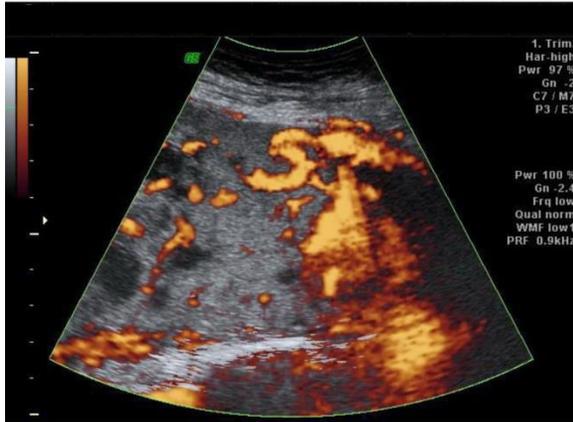


Fig.2. Placenta increta in 29 year old pregnant female patient at 25 weeks of gestation came for routine antenatal examination with history of previous 4 C.S. Color Doppler shows hypoechoic spaces which are vascular and therefore represent placental lacunae giving the characteristic "swiss cheese appearance". Note the presence of hypervascularity of the interface between the uterine serosa and the bladder wall. Patient was found to have placenta accreta at delivery.

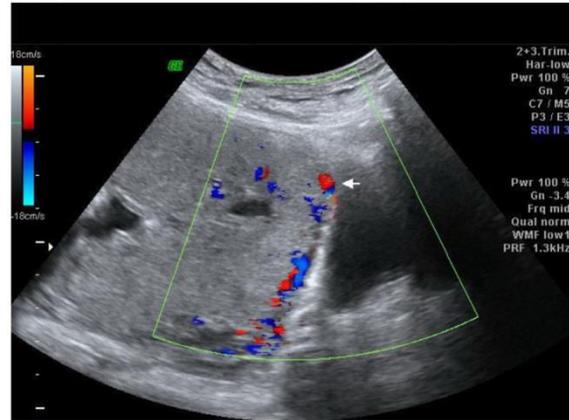


Fig.3. Placenta percreta in 26 year old pregnant female patient at 30 weeks of gestation came to the obstetric department by vaginal bleeding with history of previous 2 C.S. Color Doppler showing the placenta is extending to the serosal surface of the bladder without any intervening myometrium. By color Doppler, suspected crossing vasculature from uterine serosa to bladder. Patient was found to have placenta increta.US had displayed false positive diagnosis of invasion in 2 cases, true negative in 7 cases and false negative in 3 cases.

Table 1. Sonographic findings of the cases

Variables		US				P value
		Accreta n=7	Increta n=2	Percreta n=1	No invasion n=10	
Age(years)		33.14±4.6	30±2.1	26	32.1±3.9	0.432
Gestational age(weeks)		33.2±3.9	28.5±4.9	30	33±3.8	0.961
Prior CS		3±2	3±1	2	2.7±1.4	0.357
Abnormal clear space	Yes	7(100%)	2(100%)	1(100%)	0	0.000*
	No	0	0	0	10(100%)	
Loss of bladder uterine interface	Yes	4(57.1%)	2(100%)	1(100%)	0	0.006**
	No	3(42.9%)	0	0	10(100%)	
Placenta Lacunae	Yes	0	2(100%)	1(100%)	0	0.000**
	No	7(100%)	0	0	10(100%)	

Hyper Vascularity	Yes	0	2(100%)	1(100%)	0	0.000**
	No	7(100%)	0	0	10(100%)	
Decreased Myometrium Thickness	Yes	7(100%)	2(100%)	1(100%)	0	0.000**
	no	0	0	0	10(100%)	

**Chi-square test was used to compare proportions between groups

*ANOVA

*statistically significant at <.05

There were statistical difference by MRI between the placenta accreta, increta, percreta and non invasion cases concerning heterogeneous signal intensity (P value=0.01), dark intraplacental bands (P value=0.003), focal interruption in the myometrium (P value=0.000), (Table.2). MRI had suggested true-positive diagnosis of invasion in 100% (n = 11/11). (Fig. 4, Fig.5, Fig. 6) .

Matching between MRI and caesarean delivery result of the positive cases of invasion, MRI had diagnosed 11 cases of the 11 cases which proved to have invasion correctly after delivery. MRI had correctly diagnosed the degree of invasion in 10 cases of the proved 11 cases with invasion. MRI had over estimated the degree of invasion in only one case which had overestimated as increta instead of accrete.



Fig. 4. Placenta accreta in 34 year old pregnant female patient at 32 weeks of

gestation, came at the obstetric department by vaginal bleeding with history of previous 3 C.S. Sagittal T2-weighted FSE showing inhomogeneous placenta with marked thinning of the myometrium . Distinct plane of cleavage between the myometrium and the urinary bladder. Patient was found to have placenta accreta at delivery.



Fig.5. Placenta increta in 26 year old pregnant female patient at 30 weeks of gestation, came to the obstetric department by vaginal bleeding with history of previous 2 C.S. Sagittal T2-weighted FSE MRI image showing thickened & macrolobulated placenta with placental lacunae . Evidence of infiltration of inner layer of the myometrium in the lower uterine segment anteriorly (Arrowed) . Patient was found to have placenta increta.

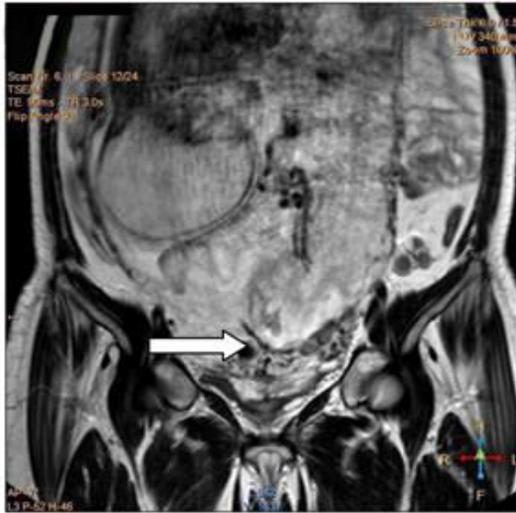


Figure 6.a



Figure 6.b

Fig. 6. Placenta percreta in 30 year old pregnant female patient at 28 weeks of gestation, was known to have placenta previa during routine antenatal examination with history of previous 5 C.S. Coronal T2 weighted(a)&sagittal T2 weighted(b)FSE MRI images show thickened, heterogenous placenta with

nodular outlines. Suspicion of percreta by the presence of vessels crossing between the bladder & myometrium in the uterovesical space (block arrow) as well as non visualization of both layers of the myometrium of the lower uterine segment (arrowed).Note the presence of dark placental bands. Patient was found to have placenta percreta at delivery. MRI had displayed true negative in 9 cases.

From 11 cases definitely diagnosed pathologically to have placental invasion, only 10 cases had diagnosed by US to have placental invasion while all of the 11 cases had diagnosed by MRI to have placental invasion. On the other hand we had 9 cases with no invasion pathologically and by MRI, but US diagnosed 10 cases as with no placental invasion which prove that MRI is more accurate than US in diagnosis of placental invasion. (Table.3)

TP,TN, FP, FN ,sensitivity, specificity, NPV, PPV, accuracy of US was 8,7,2,3, 72.7, 77.8, 70,80, 75 respectively. But TP,TN, FP, FN ,sensitivity, specificity, NPV, PPV, accuracy of MRI was 11,9,0,0,100,100,100,100,100respectivel y.(Table. 5, Table. 6)

Table 2. MRI findings of the cases

Variables		MRI				P value
		Accreta N=5	Increta N=3	Percreta N=3	No invasion N=9	
Uterine plug	Yes	2(40%)	0	1(33.3)	0	0.147
	No	3(60%)	3(100%)	2(66.7%)	9(100%)	
Heterogeneous Signal Intensity	Yes	4(80%)	3(100%)	3(100%)	0	0.001**
	No	1(20%)	0	0	9(100%)	
Dark Intraplental Bands	Yes	4(80%)	2(66.7%)	3(100%)	0	0.003**
	No	1(20%)	1(33.7%)	0	9(100%)	
Focal Interruption in the Myometrium	Yes	5(100%)	3(100%)	3(100%)	0	0.000**
	No	0	0	0	9(100%)	
Invasion of Surrounding	Yes	0	0	2(66.7%)	0	.006**
	No	5(100%)	3(100%)	1(33.3%)	9(100%)	

**Chi-square test was used to compare proportions between groups

*statistically significant at <.05

Table 3. Comparison of diagnosis of placental invasion by US, MRI and final pathological diagnosis

Maneuver	Cases	
	Invasion	No invasion
US	10	10
MRI	11	9
PATHOLOGICAL	11	9

Table 4. Comparison between US and MRI and operation in detection of invasion

Variables	Diagnosis by Pathologic Examination				P value
	Accreta N=6	Increta N=2	Percreta N=3	No invasion N=9	
MRI Diagnosis					0.42
positive	5(83.3%)	2(100%)	3(100%)	9(100%)	
negative	1(16.7%)	0	0	0	
US Diagnosis					0.04**

Positive	2(33.3%)	0	0	7(77.8%)	
negative	4(66.7%)	2(100%)	3(100%)	2(22.2%)	

*Chi-square test was used to compare proportions between groups

*statistically significant at <.05

Matching the result of the US and caesarean delivery data of the diagnosed cases as accreta(N=6), only 2 cases US diagnosed them as accreta while 3 cases US diagnosed them as placenta previa only with no invasion and one case US diagnosed it as increta.

Matching the result of the US and caesarean delivery data of the diagnosed cases as increta(N=2), US could not diagnose any case of them(one case diagnosed as percreta and the other one diagnosed as accreta by US).

Matching the result of the US and caesarean delivery data of the diagnosed cases as percreta(N=3), US

could not diagnose any case of them(one case diagnosed as increta and the other two cases diagnosed as accreta by US).

Matching the result of the US and caesarean delivery data of the diagnosed cases as with no placental invasion(N=9), US diagnosed only 7 cases as with no placental invasion although the other 2 cases US diagnosed them as accreta.

Matching the result of the MRI and caesarean delivery data of the diagnosed cases, MRI diagnosed all the cases correctly except in one case which diagnosed by MRI as increta and it was accreta after delivery.

Table 5. Comparison between ultrasound and operation , comparison between MRI and operation in ability to detect placental invasion

Variables		Invasion	No invasion	Total	P value
US	positive	8	2	20	0.027*
	negative	3	7		
MRI	positive	11	0	20	0.000*
	negative	0	9		

Table 6. Sensitivity ,Specificity ,NPV ,PPV and accuracy of MRI and Doppler US

	TP	TN	FP	FN	Sensitivity	specificity	NPV	PPV	accuracy
Doppler US	8	7	2	3	72.7	77.8	70	80	75
MRI	11	9	0	0	100	100	100	100	100

Discussion

Placenta Accreta Spectrum (PAS) refers to the range of abnormally adhesive and penetrative placental tissue at a uterine scar. Placenta accreta spectrum is divided into accreta, increta and percreta based on degree of myometrial invasion. Its incidence has increased. Placenta accreta spectrum is now the leading indication for emergency peripartum hysterectomy in the setting of catastrophic hemorrhage from a non-separating placenta (**Thanawala et al., 2020**).

In our study, There were statistical difference by US between the placenta accreta, increta, percreta and non invasion cases concerning abnormal clear space (P value=0.000), loss of bladder uterine interface (P value=0.006), decreased myometrium thickness(P value=0.000).

There were statistical difference by MRI between the placenta accreta, increta, percreta and non invasion cases concerning heterogeneous signal intensity (P value=0.01), dark intraplacental bands (P value=0.003), focal interruption in the myometrium (P value=0.000).

TP,TN, FP, FN ,sensitivity, specificity, NPV, PPV, accuracy of US was 8,7,2,3, 72.7, 77.8, 70,80, 75 respectively. But TP,TN, FP, FN ,sensitivity, specificity, NPV, PPV, accuracy of MRI was 11,9,0,0,100,100,100,100,100 respectively.

Ahmed et al. (2020) conducted a prospective study included 50 patients aged from 20 to 40 years for high risk of developing or suspected to have PAD.

The patients were evaluated by US and MRI and diagnosis was matched to postnatal outcomes. At gestational age that ranged from 20 to 39 weeks all gravid women were examined using MRI and US. The sensitivity of the US in the evaluation of PAD was 100%, the specificity 78.95%, positive predictive value 60%, negative predictive value 100%, and the overall accuracy was about 84%. The sensitivity of MRI in the evaluation of PAD was 100%, the specificity 89.47%, positive predictive value 75%, negative predictive value 100%, and the overall accuracy was about 92%. The P value for both US and MRI diagnoses of PAD was less than 0.001.

El Wakeel et al., 2018 in a combined prospective and retrospective study was carried out on 20 pregnant women with persistent placenta previa (after 28 weeks gestation) they reported that The sensitivity and specificity of ultrasonography were 63.6 and 91.6%, whereas the sensitivity and specificity of MRI were 72.70 and 100% respectively, in their ability to diagnose Placenta accreta.

Hashem et al., 2016 conducted a study on gravid females with placenta previa at high risk of coexisting placental adhesive disorders ($n = 39/50$). The sensitivity and specificity of US were 68% and 78.57% respectively while those of MRI were 80% and 85.71% respectively in their ability to diagnose placental invasion.

Kumar et al., 2017 reported results of a study done on Twenty-two patients, which were clinically stratified as a risk group for underlying invasive placental abnormality, underwent

Doppler sonography and magnetic resonance imaging (MRI). Abnormal placental invasiveness was assessed using various Doppler sonography and MRI signs. All the cases were correlated with surgical and pathological findings. They found that 9 patients had surgical and pathological confirmation of placental adhesive disorders, of which eight were predicted correctly by MRI (true positive) while one was misdiagnosed as normal placenta (false negative). All the nine cases were correctly identified by Doppler sonography. MRI was more accurate in predicting bladder invasion, identifying 5/6 cases.

Wang et al., 2017 reported that overall, 168 consecutive patients with suspected placenta previa were referred for MRI before caesarean section (CS). The ability of MRI to properly detect and assess abnormal placentation was correlated with findings at CS, which were considered the reference standard diagnostic tool. For each patient, MRI was used to determine whether the AP (adhesive placenta) was suitable for complete / incomplete delivery, hysterectomy, or conservative treatment. Placenta previa was detected at MRI in 63 patients and AP (adhesive placenta) in 105 patients; 16 patients had false-positive MRI findings, and three had false-negative findings. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of MRI compared to findings at CS were 88.9% (149 of 168), 96.7% (89 of 92), 78.9% (60 of 76), 84.8% (89 of 105), and 95.2% (60 of 63), respectively.

Budorick et al. (2017) in a blinded retrospective review was undertaken of US and MRI findings

from 45 patients who had an obstetrical US and placental MRI between August 2006 and January 2012. Correlation with clinical history and pathologic findings was performed; they reported that US and MRI had similar sensitivity, specificity and positive and negative predictive values for placenta accreta. The best predictors of invasion by US were loss of the myometrial mantle, increased intraplacental vascularity and loss of the bladder wall echogenicity. The best predictors of invasion by MRI were loss of retroplacental myometrial mantle, a heterogeneous placenta, and intraplacental hemorrhage.

Algebally et al.(2014) conducted a study included 100 pregnant women with placenta previa with and without abnormal placentation. The results of MRI and US in abnormal placentation were compared with post-operative data. The patients' files were reviewed for assessment of operative and post-operative morbidity. US and MRI showed no significant difference in sensitivity and specificity in diagnosing abnormal placentation (97–100% and 94–100%, respectively). MRI was more sensitive than US for the detection of myometrial invasion and the type of abnormal placentation (73.5% and 47%, respectively).

MRI demonstrated a higher diagnostic accuracy than US to detect PAS. However, since the combination of MRI and US signs could improve the probability to detect PAS, a complementary diagnostic role of these techniques could be considered (**Romeo et al., 2019**).

Conclusion

Magnetic resonance imaging is better than ultrasound for the accurate

diagnosis of placental adherence/invasion.

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