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Comparison between abdominal ultrasound and nuclear magnetic resonance imaging detection of placenta accreta in the second and third trimester of pregnancy

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Abstract

This study is to determine accuracy of abdominal ultrasound and nuclear magnetic resonance imaging (MRI) for placenta accreta in the second and third trimester of pregnancy and to define the most relevant features of abdominal ultrasound and MRI for placenta accreta prediction.

Between September 2012 and September 2018, 245 high risk of placenta accreta in the second trimester of pregnancy were prenatal diagnosed by abdominal ultrasound and MRI and they were followed up until the end of pregnancy.

Forty-six patients at the second trimester of pregnancy and 40 patients at the third trimester of pregnancy were confirmed as placenta accreta. For the second and third trimester of pregnancy, the sensitivity (Se), specificity (Sp), positive and negative predictive value (PPV and NPV) of abdominal ultrasound were 95.65% versus 97.50%, 91.78% versus 90.70%, 88% versus 83%, and 97% versus 99%, respectively, while the Se, Sp, PPV, and NPV of MRI were 89.13% versus 92.50%, 87.67% versus 8721%, 82% versus 77%, and 93% versus 96%, respectively. Five features having significant statistical differences between normal placentation women and placenta accreta patients in second or third trimester of pregnancy, including loss of the normal retroplacental clear space, thinning or disappearance of the myometrium, increased vascularization at the uterine serosa-bladder wall interface, and vascularization perpendicular to the uterine wall on abdominal ultrasound, and uterine bulging and dark intraplacental bands on MRI.

Abdominal ultrasound and MRI for placenta accreta in the second and third trimester of pregnancy could provide meaningful imaging evidences.

Abbreviations: MRI = nuclear magnetic resonance imaging, NPV = negative predictive value, PPV = positive predictive value, Se = sensitivity, Sp = specificity.

Keywords: abdominal ultrasound, comparison, nuclear magnetic resonance imaging, placenta accreta, prediction

1. Introduction

Placenta accreta is an abnormal placental implantation, which is due to the reduction or disappearance of the decidua between the placenta and the uterine wall, the direct contact between the placenta and the uterine myometrium, or the invasion or penetration of placental villi into the uterine myometrium.[1,2] Some studies pointed out that placenta previa, cesarean section, old age, multiple births, abortion, and uterine operation are higher-risk factors for placenta accrete.[3,4] The incidence of placenta accretais 0.04% to 0.4%.[5] Placenta accreta not only increases the difficulty of delivery, but also tends to cause uncontrollable uterine bleeding, which leads to hysterectomy and even endangers the lives of pregnant women and fetuses.[6,7] Therefore, it is very necessary to accurately diagnose placenta accreta before delivery, which can guide the clinical selection of the best treatment scheme and avoid the risk of multiple complications including postpartum hemorrhage, hysterorrhexis, hysterectomy, and so on.

At present, the diagnosis of placenta accreta is still lack of obvious clinical manifestations and characteristic experimental testing, which enhance the difficult to accurately diagnose placenta accreta before delivery.[6,8] Pathological examination is considered as the "gold standard" for the diagnosis of placenta accrete.[9] However, most cases having mild placenta accreta cannot be obtained pathological examination because of conservative treatment.[10] Molecular biology, a non-invasive examination, is not widely used in clinic because of its lack of specificity, including detection of maternal creatine kinase, free fetal DNA detection, and human chorionic gonadotropin mRNA detection etc.[11] Imaging examination is the most commonly

method to diagnose placenta accreta, including MRI and ultrasound examination. The soft tissue resolution and the imaging range of MRI is high, which is propitious to detect the location of placenta attachment, the scope and extent of placental invasion, and the involvement of adjacent tissues.[12] Studies pointed out that MRI has a good correlation with the prognosis of operation, which can guide the selection of obstetric surgical scheme.[13] Ultrasound is the most commonly method for diagnosis of placenta accreta because of its low cost, non-invasive, simple, and reproducible, which can well reflect the changes of blood flow.[14,15] However, due to the different experimental design and evaluation methods, the accuracy of prenatal diagnosis of placenta accreta by ultrasound and MRI reported in different literatures is quite different. Furthermore, overdiagnosis and underdiagnosis still occur ultrasound or MRI are used alone for diagnosis.[16,17]

Therefore, to understand the value of ultrasound and MRI in placenta accreta diagnosis, we investigated the accuracy of abdominal ultrasound and MRI in different trimester of pregnancy and define the most relevant features of abdominal ultrasound and MRI for placenta accreta prediction.

2. Materials and methods

2.1. Patients and clinical samples

A retrospectively study that medical records of pregnant women from our obstetric and radiologic databases between September, 2012 and September, 2018 was conducted. Two hundred forty five pregnant women with suspected placenta accreta were evaluated for the possibility of placenta accreta using abdominal ultrasound and MRI, 86 placenta accreta patients were ultimately determined by clinical and pathologic diagnosis. Placenta accreta was confirmed by pathologic findings and by clinical criteria at the time of delivery. The normal placenta was defined that it was easily removed during cesarean delivery without bleeding complications. Abnormal adherent placenta was diagnosed based on the final histology after hysterectomy and clinical information provided at the time of delivery and surgery. The placenta percreta was determined that the placenta had reached the uterine serosa or the adjacent organs. The placenta was considered as accreta when the delivery. Clinical information included gestational age at the time of diagnosis, parity, previous uterine surgery, pathologic diagnosis, and clinical findings at the time of surgery. Cesarean hysterectomy was recommended as the primary treatment for most women thought to have placenta accreta. The suspected depth of myometrial involvement did not affect counseling or clinical management, and for the purposes of this report, the diagnosis of placenta accreta refers to placenta increta and percreta as well as accreta. This study received approve of the institutional review board of RuiAn People's Hospital.

2.2. Abdominal ultrasound and MRI

Abdominal ultrasound and MRI were performed by obstetricians or radiologists experienced in abnormal adherent placenta. Ultrasounds were performed using the equipment including the IU 22 system (Philips Medical Systems, Bothell, WA) and the GE Voluson 730 or E8 (GE Medical Systems, Zipf, Austria) with 4 to 9 MHz or 5 to 9 MHz transabdominal transducers, and 3 to 9 MHz and 4 to 8 MHz endovaginal transducers. MRI was

performed with a 1.5 Tesla scanner General Electric (GE Healthcare, Waukesha, WI). The MRI protocols were similar in both hospitals and included T1-weighted sequences and T2-weighted MR sequences. Seven MRI scans were done after intravenous injection of gadolinium, 6 were MR diffusion-weighted imaging. Abdominal ultrasound images and MRI were blindly estimated by 3 experienced obstetricians and radiologists with >10 years of evaluation experience of placentation disorders, respectively.

2.3. Statistical analysis

SPSS software (version 22.0; IBM, SPSS, Chicago, USA) was used for all statistical analyses in this study. The specificity (Sp), sensitivity (Se), negative predictive value (NPV), and positive predictive value (PPV) were calculated and were compared by means of the McNemar test. A P-values $<.05$ was considered statistically significant.

3. Results

3.1. Clinicopathological characteristics of patients with placenta accreta

In this study, 245 pregnant women including 119 patients in the second trimester of pregnancy and 126 patients in the third trimester of pregnancy were found to have a diagnosis of suspected placenta accrete, which had placenta previa, previous myomectomy, or low-lying placenta with previous cesarean delivery. Eighty six patients ultimately had clinical and pathologic confirmation of placenta accreta. There were 51 pregnant women with placenta accreta/increta, 35 pregnant women with placenta percreta, and 159 pregnant women with non-adherent placenta. The clinical characteristics and patho-logical data of these placenta accrete patients were showed in Fig. 1 and described in Table 1. Fourty six placenta accreta patients at the second trimester of pregnancy was confirmed, while 40 placenta accreta patients at the third trimester of pregnancy was confirmed. For pregnant women in the second trimester of pregnancy, 10 had a vaginal delivery and 109 patients had a cesarean delivery. For pregnant women in the third trimester of pregnancy, 26 had a cesarean hysterectomy and 13 had a vaginal delivery.

3.2. The accuracy of abdominal ultrasound and MRI in diagnosing placenta accreta

To determine the accuracy of abdominal ultrasound and MRI for placenta accreta, the pregnant women in the second and third trimester of pregnancy were examined by abdominal ultrasound and MRI. For pregnant women in the second trimester of pregnancy, 44 of 46 pregnant women were diagnosed as placenta accreta using abdominal ultrasound, while 6 of 73 pregnant women were finally ascertained to have a normal placenta which ultrasound wrongfully diagnosed adherent placenta. For 2 pregnant women, abdominal ultrasound could not be interpreted because of fetal movements. Therefore, these pregnant women were considered as wrongly interpreted negative for the reason that there was a failure to identify placenta accreta and the exam was not useful for the clinical management of the patient. The diagnostic sensitivity and diagnostic specificity of abdominal ultrasound were 95.65% and 91.78% for placenta accreta of
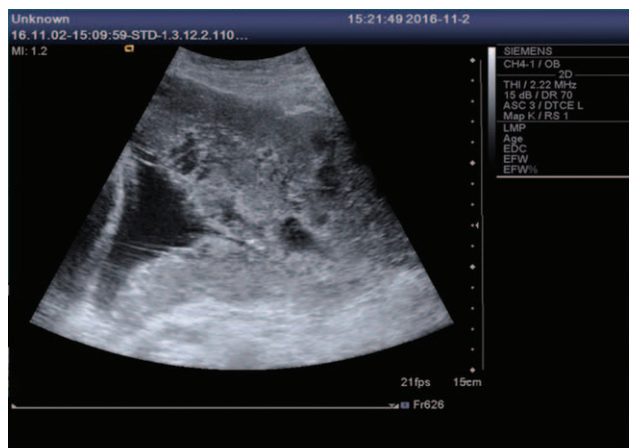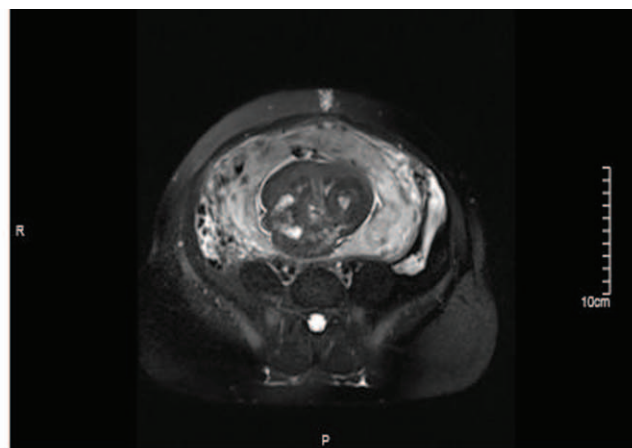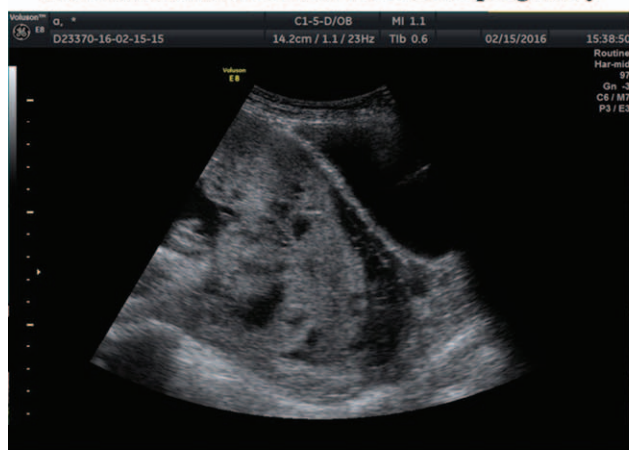
Figure 1. The clinical characteristics of placenta accrete patients in second and third pregnancy by abdominal ultrasound and MRI. MRI=nuclear magnetic resonance imaging.

pregnant women at second trimester, respectively. Furthermore, 41 of 46 pregnant women were diagnosed as placenta accreta using MRI, while 9 of 73 pregnant women were wrongfully diagnosed non-adherent placenta as placenta accreta. The diagnostic sensitivity and diagnostic specificity of abdominal ultrasound were 89.13% and 87.67% for placenta accreta of pregnant women at second trimester, respectively (Tables 2 and 3). Subsequently, we further evalua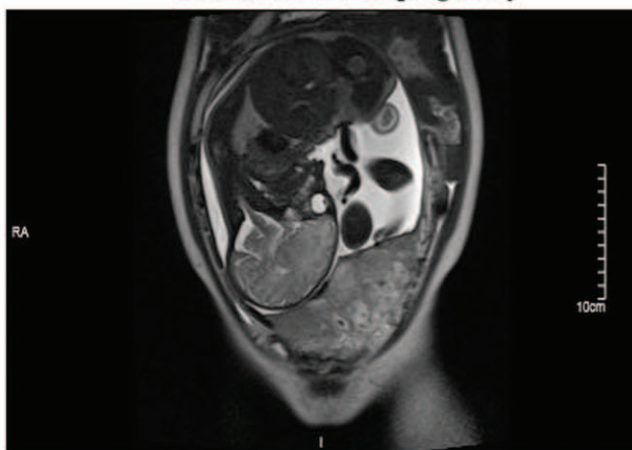ted the accuracy of abdominal ultrasound and MRI for placenta accreta of pregnant women in the third trimester of pregnancy. As shown in Tables 2 and 3, we found that abdominal ultrasound successfully diagnosed 39 of 40 pregnant women as placenta accreta, while 8 of 86 pregnant women were finally ascertained to have a normal placenta which ultrasound wrongfully diagnosed adherent placenta. Furthermore, 37 of 40 pregnant women were diagnosed as placenta accreta using MRI, while 11 of 86 pregnant women were wrongfully diagnosed non-adherent placenta as placenta accreta. The diagnostic sensitivity of abdominal ultrasound and MRI was 97.50% and 92.50% for placenta accreta of pregnant women at second trimester, respectively. The diagnostic specificity of abdominal ultrasound and MRI was 90.70% and 87.21% for placenta accreta of pregnant women at second trimester, respectively.

3.3. The concordance between abdominal ultrasound and MRI

Subsequently, we further assessed the concordance between abdominal ultrasound and MRI for placenta accreta diagnosis. For pregnant women in the second trimester of pregnancy, the data in Table 2 showed that abdominal ultrasound and MRI were concordant 90/119 patients (75.63%). We further found that 28 patients were correctly diagnosed as placenta accreta/increta and 7 patients were correctly diagnosed as placenta percreta using abdominal ultrasound and MRI. Meanwhile, 5 pregnant women were false-positive diagnoses. For discordance, we found that there was 29 pregnant women between abdominal ultrasound and MRI. Two false-negative results given by abdominal ultrasound were correctly diagnosed by MRI. Conversely, in 3 cases MRI correctly invalidated a diagnosis of placenta accreta suggested by abdominal ultrasound. The concordance between abdominal ultrasound and MRI was further evaluated for pregnant women in the third trimester of pregnancy. As showed in Table 2, we found that abdominal ultrasound and MRI were concordant 111/126 patients (88.10%). We further found that 27 patients were correctly diagnosed as placenta accreta/increta and 6 patients were correctly diagnosed as placenta percreta

Table 1

The pathological data of these placenta accreta patients.

Clinical information	Second trimester (119)	Third trimester (126)
Average age (in y)	35.3 ± 4.2	36.4 ± 4.5
Gravidity	4.1 ± 2.3	4.2 ± 2.5
Parity	2.1 ± 1.7	2.2 ± 1.6
Previous cesarean delivery (%)	93	97
Average gestational age at the time of diagnosis by ultrasonography (in wk)	20.6	34.1
Average gestational age at the time of MRI (in wk)	21.4	35.4
Placental insertion (%)		
Previa	85	89
Anterior	66	71
Posterior	19	18
Low-lying	17	18
Anterior	9	10
Posterior	8	8
Non-low-lying	17	19
Anterior	10	10
Posterior	7	9
Final diagnosis	46	40
Placenta accreta/increta	27	24
Placenta percreta	19	16
Non-adherent placenta	73	86
Surgical management at delivery		
Vaginal delivery	10	13
Conservative management	5	7
Hysterectomy	5	6
Cesarean delivery	109	113
Complete delivery	32	35
Incomplete delivery	11	12
Conservative management	39	40
Cesarean hysterectomy	27	26

MRI = nuclear magnetic resonance imaging.

using abdominal ultrasound and MRI. Meanwhile, 1 pregnant woman was false-positive diagnoses detected by abdominal ultrasound and MRI. For discordance, we found that there were 15 pregnant women between abdominal ultrasound and MRI. Two false-negative results given by abdominal ultrasound were correctly diagnosed by MRI. Conversely, 2 cases MRI correctly invalidated a diagnosis of placenta accreta suggested by abdominal ultrasound.

3.4. Features of abdominal ultrasound and MRI

To define the most relevant features of abdominal ultrasound and MRI for predict placenta accreta, abdominal ultrasound and MRI images were estimated by 3 experienced radiologists with >10 years of evaluation experience of placentation disorders, respectively. Relative to the apparent morphology of normal placenta, we found 5 features having significant statistical differences between normal placentation women and placenta accreta patients in second or third trimester of pregnancy. These features included loss of the normal retroplacental clear space, thinning or disappearance of the myometrium, increased vascularization at the uterine serosa-bladder wall interface, and vascularization perpendicular to the uterine wall on abdominal ultrasound, and uterine bulging and dark intra-placental bands on MRI. Furthermore, we assessed the specificity and sensitivity of these features. For second trimester of pregnancy, these data in Tables 4 and 5 demonstrated that loss of the normal retroplacental clear space had best sensitivity (58.70%) for diagnosis of placenta accreta, which had a specificity of 25%, while loss of the normal retroplacental clear space had best specificity (34.25%) for diagnosis of placental invasion. Moreover, increased vascularization at the uterine serosa-bladder wall interface had the poorest positive predictive value (16.67%). Intriguingly and importantly, 6 MRI scans were performed by intravenous injection of gadolinium, and MR

Table 2

Concordance and discordance between ultrasound and MRI.

Placenta accreta	Diagnosis		Second trimester		Third trimester	
			Ultrasound	MRI	Ultrasound	MRI
Positive	Correct	Single	44	41	39	37
		Both	35		33	
	Wrong	Single	2	5	1	3
		Both	2		1	
Negative	Correct	Single	67	64	78	75
		Both	55		71	
	Wrong	Single	6	9	8	11
		Both	5		6	

MRI = nuclear magnetic resonance imaging.

Table 3

Sensitivity and specificity of ultrasound and MRI.

Time		Se	Sp	PPV	NPV	Exact diagnosis
Second trimester	Ultrasound	95.65	91.78	88	97	87.43
	MRI	89.13	87.67	82	93	76.80
Third trimester	Ultrasound	97.50	0.907	83	99	88.20
	MRI	92.50	87.21	77	96	79.71

MRI = nuclear magnetic resonance imaging, NPV = negative predictive value, PPV = positive predictive value, Se = sensitivity, SP = specificity.

Table 4

Sensitivity and predictive values of abdominal ultrasound features.

	Placenta accreta/ percreta	Non-adherent placenta	P	Se	Sp	PPV	NPV
Second trimester	46	73					
Intraplacental lacunae	27	51	>.05	58.69565	69.86301	55.10204	72.85714
Loss of the normal retroplacental clear space	27	25	<.05	58.69565	34.24658	36	56.81818
Thinning or disappearance of the myometrium	25	23	<.05	54.34783	31.50685	33.33333	52.27273
Thinning or disruption of the hyperechogenic uterine serosa-bladder wall interface	18	34	>.05	39.13043	46.57534	31.57895	54.83871
Increased vascularization at the uterine serosa-bladder wall interface	13	8	<.05	28.26087	10.9589	16.66667	19.5122
Vascularization perpendicular to the uterine wall	15	9	<.05	32.6087	12.32877	18.98734	22.5
Exophytic uterine masses	17	15	<.05	36.95652	20.54795	22.66667	34.09091
Irregular bladder wall	17	21	>.05	36.95652	28.76712	24.63768	42
Pseudo-tumoral appearance of placenta, uterine bulging	11	9	>.05	23.91304	12.32877	14.66667	20.45455
Third trimester	40	86					
Intraplacental lacunae	26	69	>.05	65	80.23256	60.46512	83.13253
Loss of the normal retroplacental clear space	25	28	<.05	62.5	32.55814	30.12048	65.11628
Thinning or disappearance of the myometrium	21	27	<.05	52.5	31.39535	26.25	58.69565
Thinning or disruption of hyperechogenic uterine serosa-bladder wall interface	17	39	>.05	42.5	45.34884	26.5625	62.90323
Increased vascularization at the uterine serosa-bladder wall interface	10	8	<.05	25	9.302326	11.36364	21.05263
Vascularization perpendicular to the uterine wall	13	10	<.05	32.5	11.62791	14.60674	27.02703
Exophytic uterine masses	11	7	<.05	27.5	8.139535	12.22222	19.44444
Irregular bladder wall	15	25	>.05	37.5	29.06977	19.73684	50
Pseudo-tumoral appearance of placenta, uterine bulging	9	10	>.05	22.5	11.62791	10.58824	24.39024

NPV = negative predictive value, PPV = positive predictive value, Se = sensitivity, SP = specificity.

diffusion-weighted imaging of 5 pregnant women was executed except conventional sequences. There were no significant statistical differences between intravenous injection of gadolinium and MR diffusion-weighted imaging for the diagnosis of placenta accreta. For third trimester of pregnancy, the sensitivity and the specificity of abdominal ultrasound and MRI features summarized in Tables 4 and 5 revealed that loss of the normal retroplacental clear space with a specificity of 32.56% had best sensitivity (62.5%) for placenta accreta diagnosis, while increased vascularization at the uterine serosa-bladder wall interface had the poorest sensitivity (91%) and a low specificity (9.30%). Moreover, features which had best positive predictive value for placenta accreta diagnosis were loss of the normal retroplacental clear space. We found that there were also no

Table 5

Sensitivity and predictive values of MRI features.

	Placenta accreta/ percreta	Non-adherent placenta	P	Se	Sp	PPV	NPV
Second trimester	46	73					
Uterine bulging	22	9	<.05	47.82609	12.32877	25.5814	27.27273
Dark intraplacental bands on T2-weighted images	17	28	>.05	36.95652	38.35616	27.41935	49.12281
Disruption of the interface between placenta and myometrium on T2-weighted images	41	72	>.05	89.13043	98.63014	97.61905	93.50649
Thinning or disappearance of the myometrium	42	65	>.05	91.30435	89.0411	84	94.2029
Extension of the placenta on T2-weighted images	15	14	>.05	32.6087	19.17808	20.27027	31.11111
Presence of neovessels	11	19	>.05	23.91304	26.0274	16.92308	35.18519
Dark intraplacental bands and thinning or disappearance of the myometrium	28	47	>.05	60.86957	64.38356	51.85185	72.30769
Dark intraplacental bands and disruption of the interface between placenta and myometrium	15	27	>.05	32.6087	36.9863	24.59016	46.55172
Uterine bulging and dark intraplacental bands	18	4	<.05	39.13043	5.479452	20.68966	12.5
Third trimester	40	86					
Uterine bulging	21	10	<.05	52.5	11.62791	21.64948	34.48276
Dark intraplacental bands on T2-weighted images	15	35	>.05	37.5	40.69767	22.72727	58.33333
Disruption of the interface between placenta and myometrium on T2-weighted images	34	79	>.05	85	91.86047	82.92683	92.94118
Thinning or disappearance of the myometrium	38	68	>.05	95	79.06977	67.85714	97.14286
Extension of the placenta on T2-weighted images	12	12	>.05	30	13.95349	13.95349	30
Presence of neovessels	8	23	>.05	20	26.74419	11.26761	41.81818
Dark intraplacental bands and thinning or disappearance of the myometrium	17	29	>.05	42.5	33.72093	22.97297	55.76923
Dark intraplacental bands and disruption of the interface between placenta and myometrium	20	29	>.05	50	33.72093	25.97403	59.18367
Uterine bulging and dark intraplacental bands	15	7	<.05	37.5	8.139535	15.95745	21.875

MRI = nuclear magnetic resonance imaging, NPV = negative predictive value, PPV = positive predictive value, Se = sensitivity, SP = specificity.

significant statistical differences between intravenous injection of gadolinium and MR diffusion-weighted imaging for the diagnosis of placenta accreta.

4. Discussion

Placenta accreta, a rare and serious complication in obstetrics, can cause severe postpartum hemorrhage and is difficult to control, which increase the risk of hysterectomy and endanger maternal and infant life.[8,18] Therefore, improving the diagnostic level of placenta accreta before delivery can guide clinical treatment, determine the mode of delivery, and decrease the morbidity and mortality of perinatal mothers and infants as much as possible. At present, there is no, however, unified standard for the diagnosis of placenta accreta. Pathological examination can not only make a definite diagnosis, but also determine the type of placenta implantation. However, only a few patients with placenta accreta undergo hysterectomy.[19] With the gradual spread of conservative treatment, more applicable clinical diagnostic criteria for prenatal diagnosis of placenta accreta are needed. In this study, we evaluate the accuracy of abdominal ultrasound and MRI for placenta accreta in the second and third trimester of pregnancy by prospective assessment and to define the most relevant features of abdominal ultrasound and MRI for placenta accreta prediction. In this study, 46 patients at the second trimester of pregnancy and 40 patients at the third trimester of pregnancy was confirmed as placenta accreta. For the second and third trimester of pregnancy, abdominal ultrasound and MRI were provided with high sensitivity, high specificity, high positive and negative predictive values in diagnosing placenta accrete. More interesting, 5 features were proved to have significant statistical differences between normal placentation women and placenta accreta patients in second or third trimester of pregnancy, including loss of the normal retroplacental clear space, thinning or disappearance of the myometrium, increased vascularization at the uterine serosa-bladder wall interface, and vascularization perpendicular to the uterine wall on abdominal ultrasound, and uterine bulging and dark intraplacental bands on MRI. Taken together, we provide convincing evidence that abdominal ultrasound and MRI could provide meaningful imaging evidences for placenta accreta in the second and third trimester of pregnancy.

Many scholars have pointed out that ultrasound diagnosis of placenta accreta has a higher accuracy, and suggested that pregnant women with high risk of placenta accrete at about 20 weeks should be screened by ultrasound.[20,21] Data in our study showed that the sensitivity, specificity, positive and negative predictive value of abdominal ultrasound were 95.65%, 91.78%, 88%, and 97% for the second trimester of pregnancy, respectively. At the 15 to 20 week of pregnancy, the more blood vessels in the placenta of pregnant women are conducive to abdominal ultrasound diagnosis, which increased the sensitivity of abdominal ultrasound. However, the abdominal ultrasound in this study has misdiagnosis, which may be due to the influence of the degree of bladder filling, abdominal fat and placenta location, and other factors.[22,23] Furthermore, for the third trimester of pregnancy, the sensitivity and negative predictive value of abdominal ultrasound significantly enhanced relative to the second trimester. It may be the reason that blood vessels in the placenta of pregnant women at the third trimester was much more density.[24,25] MRI is an important imaging tools, which is

as complementary means of ultrasound for diagnosis of multiple diseases.[26,27] Subsequently, we explore the value of MRI in placenta accreta diagnosis in the second and third trimester of pregnancy. MRI showed higher Se, Sp, PPV, and NPV for placenta accreta diagnosis in the second and third trimester of pregnancy. Significantly, MRI can make up for escape diagnosis and misdiagnosis of abdominal ultrasound. When the placenta is located in the posterior wall of the uterus, MRI could find more signs that cannot be detected by ultrasound, which is more conducive to placenta accreta diagnosis. Ultrasound and MRI could find more signs supporting the diagnosis of placental implantation, which is undoubtedly a way to improve the accuracy of diagnosis. Ultrasound has been widely used in prenatal fetal malformation screening and diagnosis of placental appendages because of its simplicity, economy, and safety.[28] However, MRI cannot be used as a routine screening method because of its high cost.[29] Therefore, abdominal ultrasound can be performed in those with high risk factors of placenta accreta, and MRI can be performed to optimize the diagnostic rate if the placenta is located in the posterior wall of the uterus and the depth of placenta accreta cannot be determined.

Currently, the precise diagnostic criteria of placenta accreta are still uncertain and generally depend on the experience of imaging doctors.[30,31] Therefore, the study of placenta accreta imaging has attracted much attention. In this study, 5 features were proved to have significant statistical differences between normal placentation women and placenta accreta patients in second or third trimester of pregnancy, including loss of the normal retroplacental clear space, thinning or disappearance of the myometrium, increased vascularization at the uterine serosa-bladder wall interface, and vascularization perpendicular to the uterine wall on abdominal ultrasound, and uterine bulging and dark intraplacental bands on MRI. More importantly, in order to reduce the selective bias of the experimental samples, both abdominal ultrasound and MRI examiners were used as the subjects of this study. While, to avoid the subjective wishes of the experimenters and influence the results of the experiment, both ultrasound doctors and MRI doctors were evaluated blindly. The features of abdominal ultrasound and MRI are convenient for image doctors to distinguish placenta accreta, which improve the accuracy of placenta accreta diagnosis and guide patients to individualized treatment.

In conclusion, our study had the strengths that abdominal ultrasound and MRI have acceptable accuracy for placenta accreta in the second and third trimester of pregnancy. More interesting, 5 features, the most relevant features of abdominal ultrasound and MRI, are identified to define placenta accreta patients in second or third trimester of pregnancy. These can guide patients to individualized treatment, which is beneficial to improve their survival rate and their prognosis.

Author contributions

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