Journal of Gynecology and Obstetrics
2019; 7(5): 130-137
http://www.sciencepublishinggroup.com/j/jgo
doi: 10.11648/j.jgo.20190705.12
ISSN: 2376-7812 (Print); ISSN: 2376-7820(Online)

Research Article

MRI Distinguish the Types of Placental Accrete Ability and Finding: 27 Patients Results

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To cite this article:
Tianran Li, Xiaobin Huang, Fayu Chen, Beibei Zhang, Zhijie Yang. MRI Distinguish the Types of Placental Accrete Ability and Finding: 27 Patients Results. *Journal of Gynecology and Obstetrics*. Vol. 7, No. 5, 2019, pp. 130-137. doi: 10.11648/j.jgo.20190705.12

Received: August 17, 2019; **Accepted**: September 16, 2019; **Published**: September 26, 2019

Abstract: The placenta accrete is a kind of emergency and it leads to maternal postpartum hemorrhage, and one of the causes of death. Its aims is to evaluate diagnostic ability and findings of MRI in placental accrete of different types. This study included 27 pregnant women who were all histologically confirmed placental accrete after operation. According to the Maldjia diagnostic MRI criteria. The sensitivity and accuracy of MRI imaging were compared, and the MRI features of placental accrete were also described. The results showed a statistically significant difference among the three radiologists in MRI classification (P<0.05). For the type 0 and the type 3, there is a statistical difference between MRI diagnosis to the type 0 and the type 3 (P<0.05), and Kappa test also showed the difference (P<0.05). And for the type 1 and the type 2, especially for the type 1, there is a good consistency with the pathological results (P>0.05), chi square test (χ^2) showed no difference between the two types diagnostic capabilities (P>0.05). ADC and high b value DWI both showed slightly high signal of placental accrete. Residual placenta demonstrated "flower braid" or "mushroom" inhomogeneous enhancement. Comparison of MRI and US, 0 and 1 type are no obviously difference between US and MRI (P>0.05), but there are statistical difference (P<0.05) for distinguishing type 2 and type 3. MRI has a high diagnostic accuracy in placental implantation and the location, extent and depth of its invasion, displaying the condition of blood supply, and the drawing the typing diagnosis based on them. Moreover, MRI was more useful than US in distinguishing type 2 and type 3 of placental accrete.

Keywords: Placenta, Accrete, MRI, US

1. Background

Placental implantation abnormalities (PIAs) are kinds of disorder of the placenta dysplastic disease, including low placenta and marginal placenta, placenta previa, placenta accrete, vasa previa, and velamentous cord insertion. According to a meta-analysis in the PIAs, Low placenta and marginal placenta are 26.9%, placenta previa 43.5%, placenta accrete 57.7%, vasa previa 81.9%, and velamentous cord insertion 37.5% [1]. The Placenta accrete is due to uterine decidua dysplasia, and in order to obtain blood supply, chorionic villi tissues invade into myometrium from decidua basalis with developmental defects, even though penetrating muscularis deepth into serosa and abdominal cavity [2]. Along with the increase in cesarean section, abortion and maternal aging, more and more the placenta accrete is found in clinical works. The placenta accrete is a kind of emergency and it leads to maternal postpartum hemorrhage, and one of the causes of death, because the placenta accrete run into muscular layer depth and the fatality rate is related to postpartum hemorrhage [3].

Ultrasound (US) can provide an accurate diagnosis of PIAs, US has been reported to have a sensitivity of 91% and a specificity of 97% for the diagnosis of morbidly adherent placenta in a recent meta-analysis [4]. However, when US findings are suspicious or inconclusive for patients with high clinical risk factors, MRI (Magnetic Resonance Imaging) is recommended as an adjunct imaging technique. But pathology

is mandatory to confirm the diagnosis. MRI has the property of large field of view, good soft tissue contrast and multi-plane reconstruction, etc. So MRI has a greater advantage for judge the depth and range of the placenta accrete [5]. In cases where US has provided a definitive diagnosis, MR imaging is usually performed for delivery planning because it is able to outline the anatomy of the invasion, relate it to regional vascular system, and confirm parametrial invasion and possible ureteral involvement [6].

2. Objectives

In this study, a retrospective analysis was performed on clinical MRI data of 27 cases with the placenta accrete confirmed by postoperative pathological results. The main innovation of this paper is the MRI types of placenta accrete by means of Maldjian diagnostic criteria [7]. It is to strengthen the understanding of the MRI features in the placenta accrete, and provide more effective treatment programs for clinicians because presurgical information about the depth of invasion and location of the invasion in cases with placenta accrete is hence essential for accurate surgical planning. In addition, US examination is as control group.

3. Materials and Methods

3.1. Patients' Information and Imaging Studies

We respectively reviewed MRI findings of 27 pregnant women in our institution all histologically confirmed placental accrete after operation. MRI scanner using Siemens Verio 3.0 T magnetic resonance imaging system phased array coil and supine position scanning. 27 cases underwent conventional MRI SE sequence, T1WI (TR 400~600ms, TE 5~30ms), T2WI (TR 2000~4000ms, TE 80~150ms), STIR (TR 3000~4000ms, TE 80~150ms), including 16 cases of DWI (b=1000 mm^2/s, TR 7200ms, TE 93ms, NEX 4); 13 cases underwent VIBE sequence (TR 3.9~4.1ms, TE 1.3~1.5ms) axial dynamic contrast enhanced (CE) scanning, sagittal and coronal imaging as an adjunct. Enhancement agent is Gd-DTPA, dose of 0.1mmol/kg body weight, through elbow vein injection and the flow rate of 2.5ml/s.

3.2. Ethical Statement

The institutional review board (CWO) of the fourth medical center of the Chinese People Liberation Army (PLA) general hospital approved the study. All patients provided written informed consent and consent for publication of individual patient data.

3.3. Method of MRI Typing

According to Maldjian diagnostic criteria [7], imaging findings of placenta accrete will be divided into the following four types: Type 0: myometrial morphology, normal thickness, only local endometrium slightly blurred or normal; Type 1: the uterus enlarged, endometrium disappeared, uterine muscle layer at placenta adhesion shows thin or irregular, no invasive placenta; Type 2: the placenta invade muscle layer, boundary of muscular layer and placenta tissue is not clear, but did not penetrate the serosal layer; Type 3: the invasion of uterine serosa, even penetrating serosa layer to the bladder, rectum and other adjacent organs, Interstitial adipose tissue of uterus and adjacent tissues disappeared or not clear.

We adopted the Maldjian diagnostic criteria for distinguishing the placenta accrete types, and observing MRI diagnosis ability. Three radiologists performed independent judgment on the MRI finding of placenta accrete and the Maldjia diagnostic criteria for MRI typing.

Diffusion weighted imaging (DWI) and enhanced imaging feature of placenta accrete and MRI finding of residual and complications of placenta accrete were observed and described.

3.4. Method of Pathological Analysis

Pathological diagnosis: the uterus specimens were observed under the microscope. Type 0: only local endometrium slightly blurred or normal; Type 1: Placental villi invade the myometrium surface; Type 2: The villi has embedded into myometrium; Type 3: The villi penetrate into the myometrium and arrived the serous layer or extra-serous layer tissue [8].

3.5. Statistical Analysis Methods

The SPSS 16.0 statistical software was applied to analyze data, which crosstabs test was used to analyze the difference of three radiologists, the specificity and sensitivity using the *Kappa* test. A value of $P \leq 0.05$ was considered statistically significant.

4. Results

4.1. Patients' General Information

In all 27 pregnant women, the expulsion of the placenta after birth incomplete or not discharge 21 patients, irregular vaginal bleeding after spontaneous abortion or induced abortion 6 patients. All cases were surgically removed. The average age of patients was 27.74±3.61.

4.2. MRI Type Classification

Three radiologists diagnosed independently to 27 patients, and the pathological results were "gold standard" (Table 1). Three radiologists independently read MRI images. According to the majority rule, 27 cases totally were predicted of placenta accrete, MRI type classification. Three pathologists based by the MRI typing criteria (Table 1) gave pathological classification.

Table 1. *Three radiologists and ultrasonologist diagnosed in different methods (Type).*

No.	Age (year)	Gestational age (week)	MRI and US classification			Pathological classification results
			Radiologist (Ultrasonologist) 1	Radiologist (Ultrasonologist) 2	Radiologist (Ultrasonologist) 3	
1	24	25	2 (2)	3 (2)	2 (2)	2
2	25	26	3 (2)	3 (3)	3 (3)	3
3	32	20	2 (2)	2 (1)	3 (2)	2
4	25	32	3 (3)	3 (3)	3 (3)	3
5	31	37	1 (2)	2 (0)	2 (1)	2
6	22	36	2 (2)	2 (3)	3 (2)	3
7	22	31	0 (0)	1 (0)	0 (1)	1
8	24	39	0 (0)	0 (0)	0 (0)	0
9	27	40	2 (1)	3 (1)	2 (2)	3
10	29	37	2 (2)	1 (2)	1 (0)	2
11	23	32	2 (2)	3 (2)	2 (2)	2
12	21	37	3 (3)	3 (3)	1 (0)	3
13	26	35	0 (2)	1 (0)	0 (2)	1
14	26	41	2 (2)	1 (2)	1 (0)	2
15	22	40	3 (3)	2 (0)	3 (1)	3
16	29	37	0 (2)	1 (0)	2 (1)	1
17	33	38	2 (2)	3 (3)	3 (2)	3
18	38	39	1 (1)	1 (1)	1 (2)	2
19	29	40	2 (2)	1 (2)	2 (0)	2
20	39	41	3 (3)	3 (3)	3 (3)	3
21	36	39	2 (2)	1 (0)	0 (1)	3
22	24	40	2 (2)	3 (3)	3 (3)	3
23	25	38	0 (0)	0 (1)	0 (0)	2
24	34	37	2 (2)	2 (2)	2 (3)	3
25	31	39	1 (2)	2 (2)	1 (2)	2
26	30	40	3 (3)	3 (3)	2 (2)	3
27	22	41	2 (2)	2 (0)	2 (2)	3

Pathological classification result as a gold standard.

4.3. MRI Types Efficacy Analysis

MRI diagnostic efficiency results of placenta accrete types (Table 2).

Table 2. *Type's efficacy analysis results of MRI and US diagnosis of placenta implantation.*

MRI classification	Radiologists (Ultrasonologist)				Pathological classification
	1	2	3	consensus	
0	5 (3)	2 (5)	5 (4)	4 (4)	1
1	3 (2)	8 (4)	5 (5)	5 (4)	3
2	13 (16)	7 (7)	9 (11)	10 (8)	10
3	6 (5)	10 (8)	8 (5)	8 (5)	13

The results showed a statistically significant difference among the three radiologists (Pearson chi square test, χ^2=118.00, P<0.05), and the further analysis results seen in Tables 3, 4.

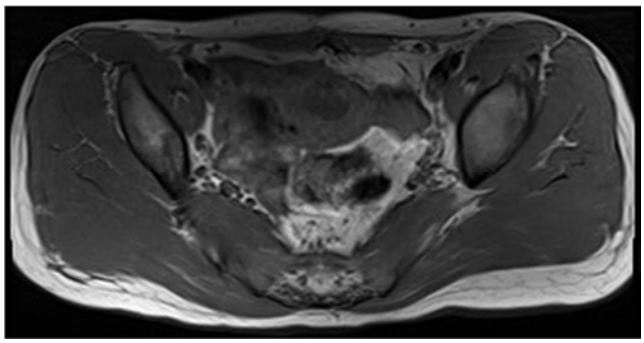
Table 3. *Pathological result as a gold criterion, diagnostic performance of MRI classification by three radiologists (%).*

MRI classification	Radiologist 1				Radiologist 2				Radiologist 3			
	0	1	2	3	0	1	2	3	0	1	2	3
specificity	84.6%	87.5%	58.8%	81.3%	96.2%	79.2%	76.%%	75.0%	84.6%	79.2%	70.6%	81.3%
sensitivity	100%	0	60.0%	27.3%	100%	100%	30.0%	54.5%	100%	0	40.0%	45.5%
Kappa (*P*)	0.289 (0.033)	0.125 (0.516)	0.177 (0.345)	0.092 (0.601)	0.649 (0.000)	0.458 (0.005)	0.069 (0.711)	0.300 (0.118)	0.289 (0.033)	0.161 (0.381)	0.108 (0.573)	0.279 (0.135)

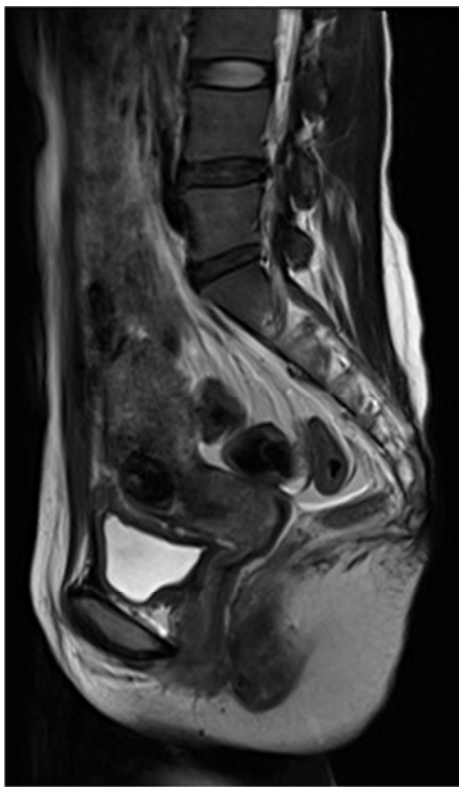
Table 4. *The analysis between the results of MRI typing based the majority of rules and pathological.*

MRI classification	Radiologist			
	0	**1**	**2**	**3**
specificity	88.5%	79.2%	70.6%	100%
sensitivity	100%	0	50.0%	61.5%
Pearson χ^2 (*P*)	5.971 (0.015)	1.259 (0.262)	1.144 (0.285)	12.243 (0.000)
Kappa (*P*)	0.362 (0.015)	0.208 (0.262)	0.206 (0.285)	0.624 (0.000)

The tables 3, 4 shows that the MRI diagnosis specificity and sensitivity of Type 0 are very high, but poor consistency with pathological results (*Kappa* test=0.289, $P<0.05$). For the Type 1, show a high specificity and the lowest sensitivity. (Figure 1). For Type 2 and 3, the specificity and the sensitivity are between type 0 and type 1 (Figures 2, 3).



A



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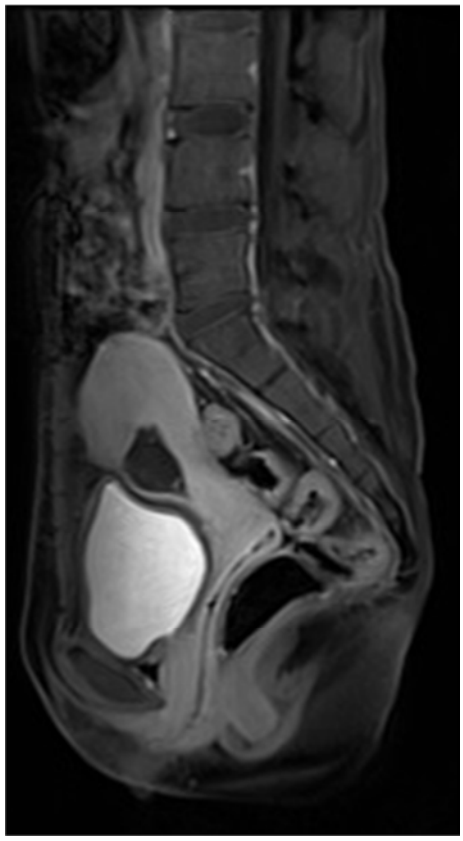
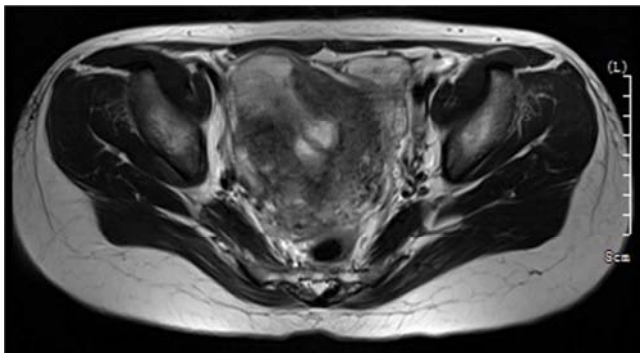


C

Figure 1. *Placenta implantation type 1. A 30-year-old patient, irregular vaginal bleeding after miscarriage. MRI shows the residual placenta and it is close to the anterior wall of the uterus. The endometrial display is not clear in T2WI. A, T1WI was slightly low signal. B, T2WI shows the residual placenta was in mixed signal. C, CE-T1WI shows the residual placenta was low signal.*



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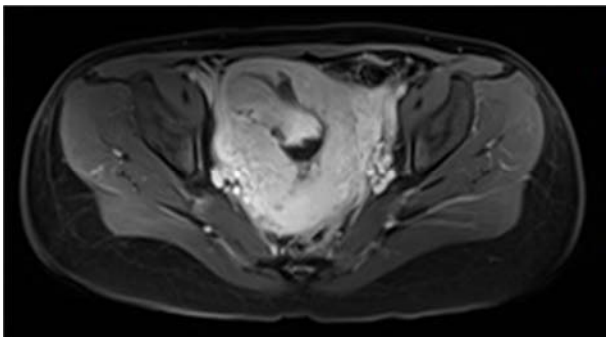

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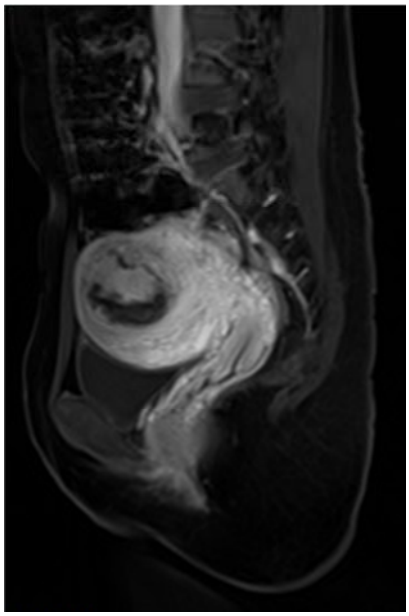
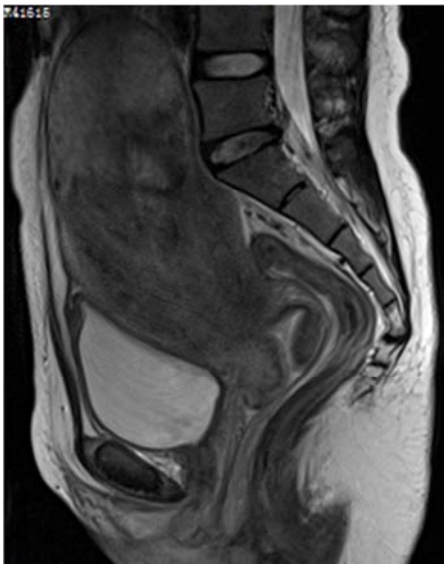
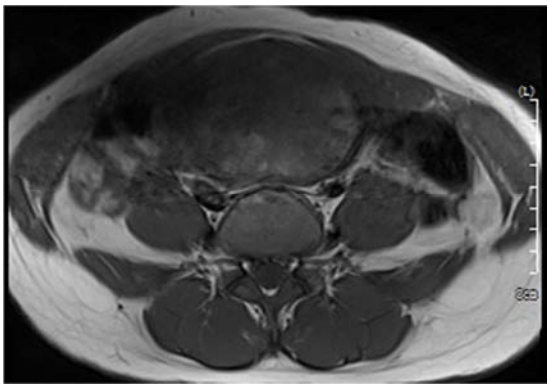


C

Figure 2. *Placenta implantation type 2. A 28-year-old patient, Postpartum hemorrhage. A, T2WI shows the uterus wall of the placenta implantation was obvious thin. B, CE-T1WI shows that the myometrium is continuous, and residual placenta was obvious enhancement. C, the Sagittal CE-T1WI shows the part of the placenta implantation connected to the myometrium.*



A



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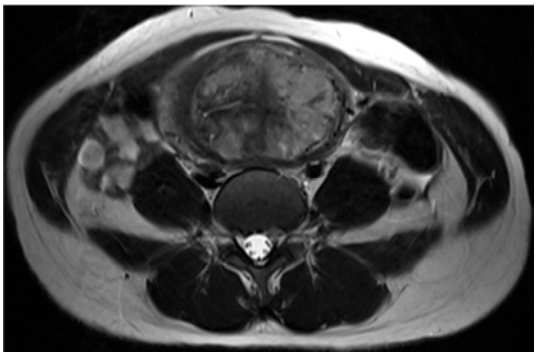

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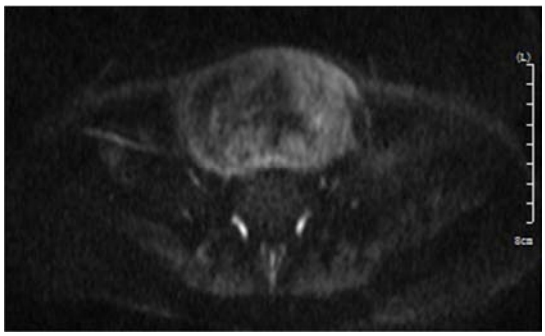
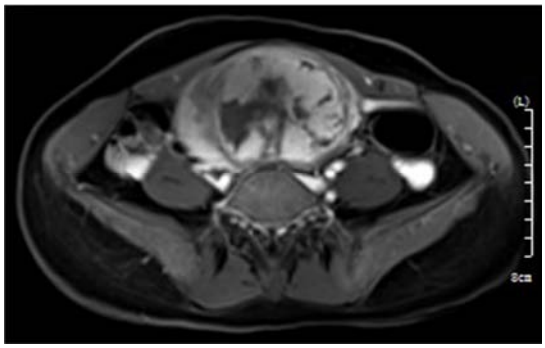


D



E

Figure 3. *Placenta implantation type 3. A 28-year-old patient, Postpartum hemorrhage. A, Sagittal T2WI shows the muscle layer at the bottom of uterine, which is the part of the placenta implantation, was obvious thin and discontinuous. B, T1WI shows that the implanted placenta was mixed signals, and high signal was bleeding. C, T2WI shows the implanted placenta mixed signal (arrow). D, High value b (b = 1000) DWI shows the high signal. E, CE-T1WI shows the implanted placenta is significantly enhancement.*

The results also showed that, in general, for the type 0 and the type 3, MRI has very high sensitivity and specificity. However, according to the analysis, there is a statistical difference between MRI diagnosis to the type 0 and the type 3 ($P<0.05$), and so MRI prefers overestimating the type 0 and underestimating the type 3. *Kappa* test also showed the difference ($P<0.05$). And for the type 1 and the type 2, especially for the type 1, there is a good consistency with the pathological results ($P>0.05$), chi square test (χ^2) showed no difference between the two types diagnostic capabilities ($P>0.05$).

4.4. Imaging of Placenta Accrete

4.4.1. DWI and Enhanced Imaging of Placenta Accrete

In addition to conventional MRI, DWI and enhanced T1WI were performed. On diffusion of sequence, ADC and high *b* value DWI both showed slightly high signal (Figure 3d).

Enhanced scanning imaging manifestations: Residual placenta demonstrated "flower braid" or "mushroom" inhomogeneous enhancement (Figure 3e), irregular necrosis can be detected in the lesion. Low signal intensity (SI) linear separation predicted the surface of placenta and uterine wall.

4.4.2. MRI Performance of Residual Placenta Accrete

Isointense or slightly hyperintense on T1WI accompanied with flocculent high SI in it (Figure 3b). Heterogeneously high SI on T2WI was higher than that of normal uterus muscular layer (Figure 3c).

4.4.3. MRI Finding of Complications

Fluid collection of the uterine cavity by 19 patients, a small amount of pelvic effusion by 10 patients, adnexal cyst by 8 patients, and the uterine fibroids by 2 patients.

4.5. Comparison of MRI and US

From Table 1 and Table 2, 0 and 1 type are no obviously difference between US and MRI ($P>0.05$), but there are statistical difference ($P<0.05$) for distinguishing type 2 and type 3, and it indicates that MRI is superior to the ultrasound in diagnosing type 2 and type 3 of placenta accrete.

5. Discussion

The abortion, induced abortion, cesarean section, puerperal infection, placenta previa and maternal age are considered to be high risk factors of placenta accrete [9]. During the period of pregnancy, uterine decidua development of the lower segment is not efficiency than the upper segment. Uterine surgery may cause secondary defects in decidua, especially injury or inflammation after cesarean section, which can cause uterine myometrium layer relatively thin accompany decreased elasticity, the myometrium layer and scar gradually replaced by fibrous tissues. If the gestational sac implanted here, decidua basalis dysplasia, villous more easily penetrate the myometrium and serosa. According to the reports, the risk of placenta accrete occurs after cesarean pregnancy is 35 times of natural labour [10]. The clinical diagnosis, when cesarean section and separation placental by hand, is very common. Placenta accrete can be diagnosed when separated difficult and surgical stripping surface roughness and bleeding, or in the case of uncontrolled bleeding after separation although uterus involution better [11, 12].

With the development of technology, the value of MRI in diagnosis of abnormal placental has attracted much attention [13]. According to the diagnostic criteria of Maldjian [7], 27 patients of our hospital were collected to analyze the diagnostic efficacy of MRI classification, and the imaging features on the postoperative residual placenta and placenta accrete complications. Our results show that MRI has the obvious value to the diagnosis of placenta accrete, in particular, to distinguish different types of placenta accrete. However, MRI and US are mainly overestimated the type 0 and underestimated the type 3. And then, MRI is better than ultrasound in distinguishing type 2 and 3 of placenta accrete. It may be related to the familiarity of radiologist on imaging findings in different types. For the type 1 and type 2, MRI has good consistency with pathological results, which indicates that MRI has good reliability for the type 1, 2. Compared with the US, MRI has obvious advantages for more conducive information, which is available. But the US is more conducive to the early screening by the advantages of low price and convenient. The result of this study is similar to Kumar's [14]. Our protocol adds DWI and Gd-DTPA enhanced sequence to help identifying complications and classification. Morita [15] point out DWI can clearly distinguish the boundaries of placenta and uterine myometrium layer, and has an important value in the diagnosis of placenta implantation degree. The invasion of myometrium demonstrate significantly enhancement different with normal myometrium layer. Residual placenta demonstrated "flower braid" or "mushroom" inhomogeneous enhancement; irregular necrosis can be detected in the lesion. Low SI linear separation predicted the surface of placenta and uterine wall. Some researchers [16, 17] believe that the outer surface of the placenta enhanced in arterial phase and uterine myometrium layer enhanced late. The range and degree of placenta accrete it can be showed clearly. The MRI has obvious advantages for the value of demonstrated complications. Reference to the outer layer of the myometrium in the same sequence, intrauterine residual placenta shows that isointense or slightly hyperintense on T1WI accompanied with flocculent high SI caused by hemorrhage. On T2WI, it shows that heterogeneously high SI accompanies with multiple dot and strip low signal. STIR is also a mixed signal. The ADC and DWI shows slightly hyperintense may be caused by fetal membranes [18]. Other imaging manifestations showed the varying uterine cavity an expansion of degrees, a small amount of intrauterine fluid or blood; some patients can combine less amount of pelvic fluid collections, adnexal cyst, and uterine fibroids and so on.

According to the special clinical history, the placenta implantation general identified was not difficult. Mainly differential diagnosed from following two kinds of disease,

identification, placenta retention and trophoblastic disease. (1) The placenta retention: the retained placenta has a clear demarcation with endometrial, and it not enhanced in enhanced scanning. So, enhanced MRI examination is helpful for differential diagnosis when the identified is difficult. (2) Trophoblastic disease: it mainly invasion of endometrial and myometrium, with a not smooth boundary, mostly vermiculata, irregular destruction, mostly early enhancement of dynamic enhancement; and patients with placenta implantation lesion edge is limited, which edge is clear and the performance continuous enhancement.

The classification of placenta implantation is very important in clinical. To the type 0 and the type 1, conservative treatment, such as drugs or conservative surgical treatment, usually adopted [19, 20]. To the type 2, interventional uterine artery infusion methotrexate and uterine artery embolization are feasible [19]. Implanted placenta after necrosis can be discharged automatically, if still unable to discharge, additive curettage for debridement, subtotal hysterectomy or hysterectomy are feasible. If classification is the type 3, a wide range of hysterectomy should be performed [21].

6. Conclusions

From our study, [1] MRI has important value in the diagnosis and different types of placenta implantation. It can definite clear the location, the range, the depth and blood supply of invasion. [2] For the type 0 and the type 3, MRI has very high sensitivity and specificity, and for the type 1 and the type 2, there is a good consistency with the pathological results. [3] MRI is significantly better than US in distinguishing type 2 and type 3. [4] MRI can provide more accurate information for clinical and guidance treatment.

Conflicts of Interest

There are no conflicts of interest.

Ethical Approval

This research is approved by Ethical Committee of the fourth medical center of the Chinese PLA general hospital (number ID: 2017-002578).

Financial Disclosure

The authors have no financial interests related to the material in the manuscript.

Abbreviations

MRI	magnetic resonance imaging
SE	spin-echo
T1WI	T1 weighted imaging
T2WI	T2 weighted imaging
TR	repetition time
TE	echo time
STIR	short time inversion recovery
NEX	number of excitation
VIBE	volumetric interpolated breath-hold examination
Gd-DTPA	gadolinium diethylene-trianmine pentaacetic acid
DWI	diffusion weighted imaging
ADC	apparent diffusion coefficient
SI	signal intensity
US	ultrasonography

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