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Research article

Diagnostic accuracy of magnetic resonance imaging in assessing placental adhesion disorder in patients with placenta previa: Correlation with histological findings

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ABSTRACT

Objective: To evaluate MRI accuracy in assessing placental adhesion disorders (PAD) in patients with placenta previa correlating imaging results with histological findings.

Materials and methods: Sixty-one patients who underwent abdomino-pelvic magnetic resonance imaging (MRI) for ultrasound suspicion of PAD were prospectively evaluated. T1- and T2-weighted images, with and without fat suppression, were obtained in the three conventional planes using a 1.5 T MRI scanner. MRI accuracy to evaluate the presence of PAD was assessed on the basis of the occurrence of the following abnormal MRI signs: 1) intraplacental dark bands; 2) focal interruption of myometrial border; 3) intraplacental abnormal vascularity; 4) uterine bulging; 5) tenting of the bladder and/or 6) direct visualization of adjacent tissues invasion only in case of percretism. Imaging results were classified as suggestive or not of PAD using histological data as standard of reference; two methods of imaging analysis were used represented by the presence of at least one (Method A) or two (Method B) abnormal MRI signs; the correlation between the presence of each abnormal MRI sign of PAD and the corresponding histological finding was also assessed.

Results: The accuracy, as the area under the receiver operating characteristic curve, was significantly ($p = 0.001$) higher for Method B (0.92, C.I. 95%: 0.82–0.97) compared to Method A (0.764, C.I. 95%: 0.64–0.86). Among the abnormal MRI signs, intraplacental dark bands and focal interruption of myometrial border were those highly correlated with histological proof of PAD ($\rho > 0.71$, $p < 0.001$, for both); as result, a modified version of Method B (Method C) was identified considering as criterion for PAD the combined presence of the two abnormal MRI signs highly correlated with histologically proven PAD; however, the accuracy of Method C was significantly ($p = 0.005$) lower (0.80, C.I. 95%: 0.67–0.89) than Method B and comparable to Method A.

Conclusions: MRI is a useful imaging technique to assess PAD in patients with placenta previa; in particular, the presence of at least two among all the abnormal MRI signs represents the most accurate criterion (Method B) to identify PAD. Although intraplacental dark bands and focal interruption of myometrial border showed the highest correlation with histological proof of PAD as well as this association was the most frequent in PAD, the combination of these latter MRI signs along with other abnormal signs should be considered diagnostic for PAD.

1. Introduction

Placental adhesion disorder (PAD) describes a spectrum of conditions in which placenta adheres in an abnormal way to the implantation site [1]; on the basis of the degree of uterine invasion by the placental chorionic villi, three variants of PAD can be distinguished as following: 1) accretism, when placental villi adhere to myometrium; 2) incretism, when placental villi invade myometrium; and 3) percretism, when placental villi invade serosa and adjacent organs such as bladder, bowel and ureters [2]. The main risk factors for PAD are placenta previa, prior

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caesarean delivery, uterine instrumentation and maternal age over 35 years [3]. PAD is associated with massive peri-partum bleeding and related clinical complication such as hypovolemic shock, coagulopathy and multiorgan failure; therefore, blood transfusion or even hysterectomy may be required. Moreover, PAD can lead to injury to surrounding organs such as bladder, bowel and ureters determining increased rates of admission to intensive care units [4,5]. The corresponding maternal mortality and morbidity rate for PAD have been estimated to be respectively 2.6% and 56%; correct antenatal imaging diagnosis of PAD may have significant clinical implication reducing delivery complications and blood loss; in particular, prepartum diagnosis of PAD allows to avoid attempts to remove placenta and to plan caesarean hysterectomy or a conservative strategy in selected cases in order to preserve fertility [6].

Ultrasound (US) is an accurate, largely available and easily performed imaging technique to diagnose placenta accreta with sensitivity and specificity values ranging respectively between 77–93% and 71–96%, as reported in the literature; however, US is operator-dependent and limited by large body habitus or in case of posterior placenta location. When US findings are equivocal, magnetic resonance imaging (MRI) has been proposed to evaluate placental myometrium invasion degree to identify PAD, due to its multiplanar imaging and excellent soft tissue resolution [7–16]. In particular, a systematic review and meta-analysis of data corresponding to 18 comparative investigations demonstrated that US and MRI have overall comparable predictive diagnostic accuracy in detecting PAD [11]; similar results have also been recently reported by Algebally et al. [12]. However, slight discrepancies between these two imaging modalities have been reported in some studies [13–17]. Several abnormal MRI signs suggestive of PAD are currently reported in the literature [7,18], but no definitive method of how using these signs in MRI interpretation has been still established.

The aim of this study was to evaluate the diagnostic accuracy of MRI in assessing PAD in a group of patients with placenta previa, correlating imaging results with histological findings obtained after caesarean section (CS) represented by placental, total or sub-total hysterectomy samples.

2. Materials and methods

2.1. Patient population

From January 2012 to December 2017, 61 consecutive consecutive pregnant patients aged between 20 and 45 years (average maternal age 33.4; average of gestational age at scan 34.7 weeks) who underwent MRI examination were prospectively enrolled. The study was approved by our Institutional Review Board and written informed consent was obtained in all patients. Inclusion criteria were the following: 1) gestational age of at least 30 weeks; 2) history of myometrium damage such as cesarean delivery or abrasive/curettage procedures on the uterus; and 3) the presence of placenta previa with suspicion of accretism by US; in particular, US was performed within one week before MRI. Clinical data of patient population are reported in Table 1. In all patients, clinical data in terms of age and number of previous cesarean delivery (CD) as well as the results of MRI studies were correlated with histological findings after CS; in particular, total or sub-total hysterectomy was performed respectively in 19 and 17 patients, while in the remaining 25 patients only placental sample was available since hysterectomy was not required.

2.2. Pathology

For patients who had total or sub-total hysterectomy, histological criteria for PAD were based on chorionic villi attachment to the myometrium: *placenta accreta* was identified when chorionic villi were not limited to the decidua basalis but attached to the myometrium without invasion, *placenta increta* was identified when chorionic villi invaded the myometrium and *placenta percreta* was identified when chorionic villi invaded the uterine serosa or were extended beyond it [2,3].

In patients in which only placental sample was available, the diagnosis of PAD was made on placental villi alterations together with clinical intrapartum findings; due to the specific nature of the disease affecting placenta, specimens were examined by a dedicated pediatric and perinatal pathologist (M.D.A.); the standard approach to placental examination included weighting and measuring of the placenta (with

Table 1
Clinical Data of Patient Population.

Patient	Age	GA (weeks) at MR exam	Gravidity	CD	Other UP	PI
#1	33	36	II	1	1	previa
#2	34	37	III	2	2	previa
#3	29	35	II	3	–	previa
#4	32	37	III	1	–	previa
#5	31	36	II	2	–	previa
#6	29	36	II	1	1	previa
#7	35	37	IV	1	–	previa
#8	31	36	I	2	–	previa
#9	30	37	III	2	2	previa
#10	34	37	II	1	1	previa
#11	33	38	II	1	1	previa
#12	37	38	III	1	1	previa
#13	37	37	XII	3	3	previa
#14	37	37	IV	1	1	previa
#15	30	37	II	1	–	previa
#16	28	35	II	1	–	previa
#17	37	34	VI	1	1	previa
#18	32	35	III	2	–	previa
#19	35	38	III	2	2	previa
#20	37	30	IV	2	2	previa
#21	34	37	II	1	1	previa
#22	45	35	III	1	1	previa
#23	33	37	III	2	2	previa
#24	40	35	III	1	1	previa
#25	29	36	II	2	–	previa
#26	27	37	II	1	1	previa
#27	32	36	II	1	1	previa
#28	36	38	II	1	1	previa
#29	41	30	IV	2	2	previa
#30	30	37	III	1	–	previa
#31	35	37	II	1	1	previa
#32	34	36	I	1	–	previa
#33	29	33	IV	2	2	previa
#34	34	30	VIII	0	4	previa
#35	31	32	III	2	0	previa
#36	41	36	III	1	0	previa
#37	29	33	II	1	0	previa
#38	40	34	VIII	1	2	previa
#39	36	32	VI	3	1	previa
#40	32	30	III	2	0	previa
#41	21	32	III	2	0	previa
#42	42	38	IV	2	1	previa
#43	40	32	II	1	0	previa
#44	38	34	II	1	0	previa
#45	36	32	II	1	0	previa
#46	40	34	V	1	3	previa
#47	36	33	II	1	0	previa
#48	31	31	III	2	0	previa
#49	38	33	II	1	0	previa
#50	35	37	IV	0	3	previa
#51	31	30	III	2	0	previa
#52	37	32	III	1	1	previa
#53	33	34	II	1	0	previa
#54	40	35	I	0	1	previa
#55	42	37	III	2	0	previa
#56	27	34	II	1	0	previa
#57	38	36	I	2	0	previa
#58	41	38	VIII	3	4	previa
#59	42	34	III	2	0	previa
#60	35	31	I	1	0	previa
#61	42	32	III	2	1	previa

Notes: GA = gestational age, **CD** = caesarian delivery, **UP** = uterine procedure (abort, curettage), **PI** = placental implantation.