

# Assessment of total placenta previa by magnetic resonance imaging and ultrasonography to detect placenta accreta and its variants

Ocena łożyska całkowicie przodującego przy pomocy rezonansu magnetycznego i ultrasonografii w celu wykrycia łożyska wrosniętego i jego wariantów

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## Abstract

**Objective:** To evaluate the importance of ultrasonography (US) and magnetic resonance imaging (MRI) in detecting placental adherence defects.

**Material and methods:** Patients diagnosed with total placenta previa (n=40) in whom hysterectomy was performed due to placental adherence defects (n=20) or in whom the placenta detached spontaneously after a Cesarean delivery (n=20) were included into the study between June 2008 and January 2011, at the Department of Obstetrics and Gynecology, Ege University (Izmir, Turkey). Gray-scale US was used to check for any placental lacunae, sub-placental sonolucent spaces or a placental mass invading the vesicouterine plane and bladder. Intra-placental lacunar turbulent blood flow and an increase in vascularization in the vesicouterine plane were evaluated with color Doppler mode. Subsequently, all patients had MRI and the results were compared with the histopathologic examinations.

**Results:** The sensitivity of MRI for diagnosis of placental adherence defects before the operation was 95%, with a specificity of 95%. In the presence of at least one diagnostic criterion, the sensitivity and specificity of US were 87.5% and 100% respectively, while the sensitivity of color Doppler US was 62.5% with a specificity of 100%.

**Conclusions:** Currently, MRI appears to be the gold standard for the diagnosis of placenta accreta. None of the ultrasonographic criteria is solely sufficient to diagnose placental adherence defects, however, they assist in the diagnostic process.

Key words: **histopathology / magnetic resonance imaging / placenta / ultrasonography /**

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## Streszczenie

**Cel pracy:** Celem pracy była ocena przydatności ultrasonografii (US) i rezonansu magnetycznego (MRI) w wykrywaniu nieprawidłowości implantacji łożyska.

**Materiał i metoda:** Do badania włączono pacjentki, które leczone były w Klinice Położnictwa i Ginekologii na Uniwersytecie Ege w Izmirze (Turcja), w okresie od czerwca 2008 do stycznia 2011, z powodu łożyska całkowicie przodującego (n=40). U 20 pacjentek wykonano histerektomię z powodu trudności w oddzieleniu łożyska a u 20 łożysko oddzieliło się samoistnie w trakcie cięcia cesarskiego. Zastosowano skalę Graya do oceny lakun w łożysku, wolnych przestrzeni pod płytą łożyska oraz masy łożyskowej naciekającej płaszczynę pęcherzowo-maciczną oraz pęcherz moczowy. W badaniu USG z kolorowym Dopplerem oceniano turbulentny przepływ krwi w lakunach wewnątrzłożyskowych oraz wzrost unaczynienia w płaszczynie pęcherzowo-maciczej. Następnie wszystkie pacjentki miały wykonane badanie MRI a wyniki porównano z oceną histopatologiczną.

**Wyniki:** Czulość badania MRI dla rozpoznania nieprawidłowości implantacji łożyska przed operacją wyniosła 95% a specyficzność również 95%. Przy obecnym przynajmniej jednym kryterium diagnostycznym, czulość i specyficzność badania USG wyniosły odpowiednio 87,5% i 100%, podczas gdy czulość kolorowego Dopplera wyniosła 62,5% a specyficzność 100%.

**Wnioski:** Obecnie badanie MRI jest złotym standardem wykrywania łożyska wrośniętego. Żadne z ultrasonograficznych kryteriów nie jest wystarczające do rozpoznania nieprawidłowości implantacji łożyska, aczkolwiek pełnią funkcję pomocniczą w procesie diagnostycznym.

Słowa kluczowe: **histopatologia / rezonans magnetyczny / łożysko / ultrasonografia /**

## Introduction

Placental adherence defects occur when trophoblastic tissue near a defect in the decidua basalis passes through the decidual layer and invades deeper parts of the uterine wall, creating three subcategories of placenta accreta, increta and percreta [1]. Previous uterine surgery, particularly delivery by Cesarean section (CS), and maternal age are the principal risk factors [2]. The incidence of placental adherence defects has been estimated at around 1/250 in recent studies [3], whereas in the 1930s and 1980s it was 1:30.000 and 1:2500, respectively [3]. Presumably, the rate increased due to a growing number of CS.

There are no symptoms which might signal placental adherence defects. The diagnosis is dependent mostly on clinical suspicion, particularly in case of a total placenta previa or a history of CS.

Diagnosis can be established by means of magnetic resonance imaging (MRI) and ultrasonography (US). Studies carried out in recent years have revealed that the specificity and sensitivity of MRI is high [4]. The specificity and sensitivity of 3-dimensional power Doppler US have also been found to be fairly high, but no ultrasonographic method is 100% accurate.

This study was conducted in order to identify the most efficient method in the pre-natal diagnosis of placenta accreta and its variants using MRI and US.

## Material and methods

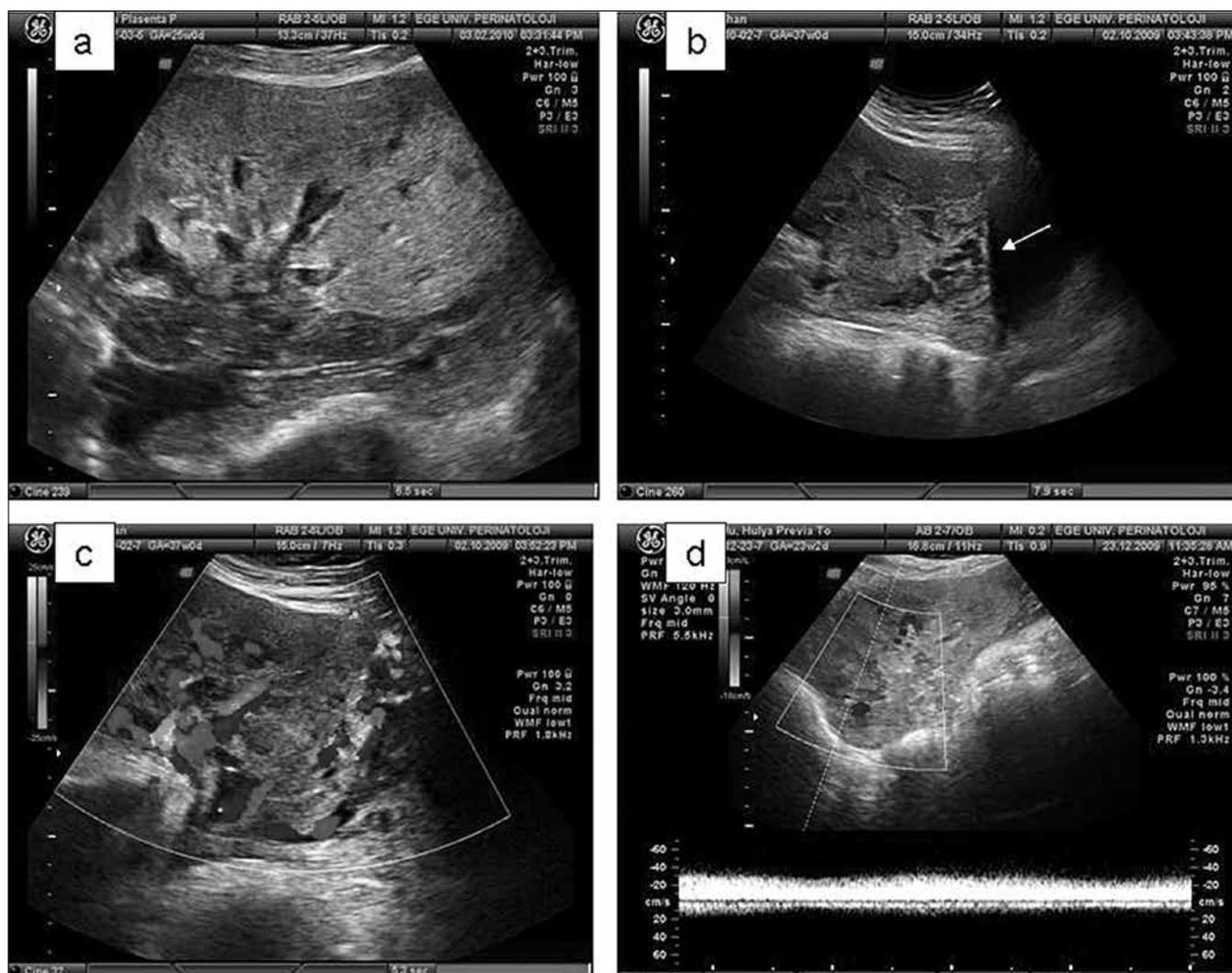
All 40 patients with the diagnosis of total placenta previa who had reached 28 weeks of pregnancy or more, and who were referred to the Ege University Faculty of Medicine, Department of Obstetrics and Gynecology (Central reference hospital for the Aegean region) between June 2008 and January 2011, were included into the study.

The approval of the Ethics Committee of Ege University was obtained. 20 patients who required hysterectomy constituted the study group and the last 20 cases with placenta previa that detached spontaneously comprised the control group. US and MRI assessment was performed in all patients. Gray-scale mode US was followed by color Doppler evaluation. A detailed obstetric history was taken and systemic physical and obstetric examinations were conducted. An informed consent was obtained before the commencement of the study.

The placenta was assessed using a 4-8 MHz transabdominal probe (Voluson 730, GE, Medical Systems, Zipf, Austria). The form and number of placental lacunae (grade 0-1-2-3) (Figure 1a), were assessed according to Finberg's criteria [5]. Sub-placental sonolucent spaces, the regularity of the vesicouterine plane (Figure 1b) and signs of any placental mass invading the bladder and/or uterine wall were noted. Following the gray-scale US, color Doppler mode was switched on during the same session and intra-placental lacunar turbulent blood flow with high-velocity (peak systolic blood flow >15 cm/s) (Figure 1d) and also abnormal vascularization in the vesicouterine plane (Figure 1c) were assessed.

Next, fetal sonographic biometric measurements were collected and the amniotic fluid level was measured. All patients, regardless of the suspected invasion, had MRI with a 1.5-T unit (Magnetom Symphony, Siemens, Erlangen, Germany).

To better evaluate bladder involvement, it had to be at least partially filled and thus the patients were examined 45 minutes after ingesting one liter of drinking water. T2-weighted images were obtained in all three planes (axial, sagittal and coronal) with half-fourier acquisition single shot turbo spin echo (HASTE), true fast imaging with steady state precession (True-FISP) and fast spin echo (FSE) sequences.



**Figure 1.** Placental lacunae (a), irregular bladder-uterine serosa border (arrow) (b), abnormal vascularization in the bladder-uterine serosa border (c), intra-placental lacunar turbulent blood flow with high-velocity (peak systolic blood flow >15 cm/s) (d).

For the MRI diagnosis of placenta accreta, criteria previously reported in literature were used:

1. abnormal uterine bulging, (Figure 2a),
2. dark intraplacental bands on T2-weighted images, (Figure 2b),
3. heterogeneous signal intensity within the placenta, (Figure 2c),
4. direct visualization of the invasion of pelvic structures by placental tissue and
5. loss of the tissue plane between the placenta and the bladder wall, (Figure 2d) [6-7-8-9-10].

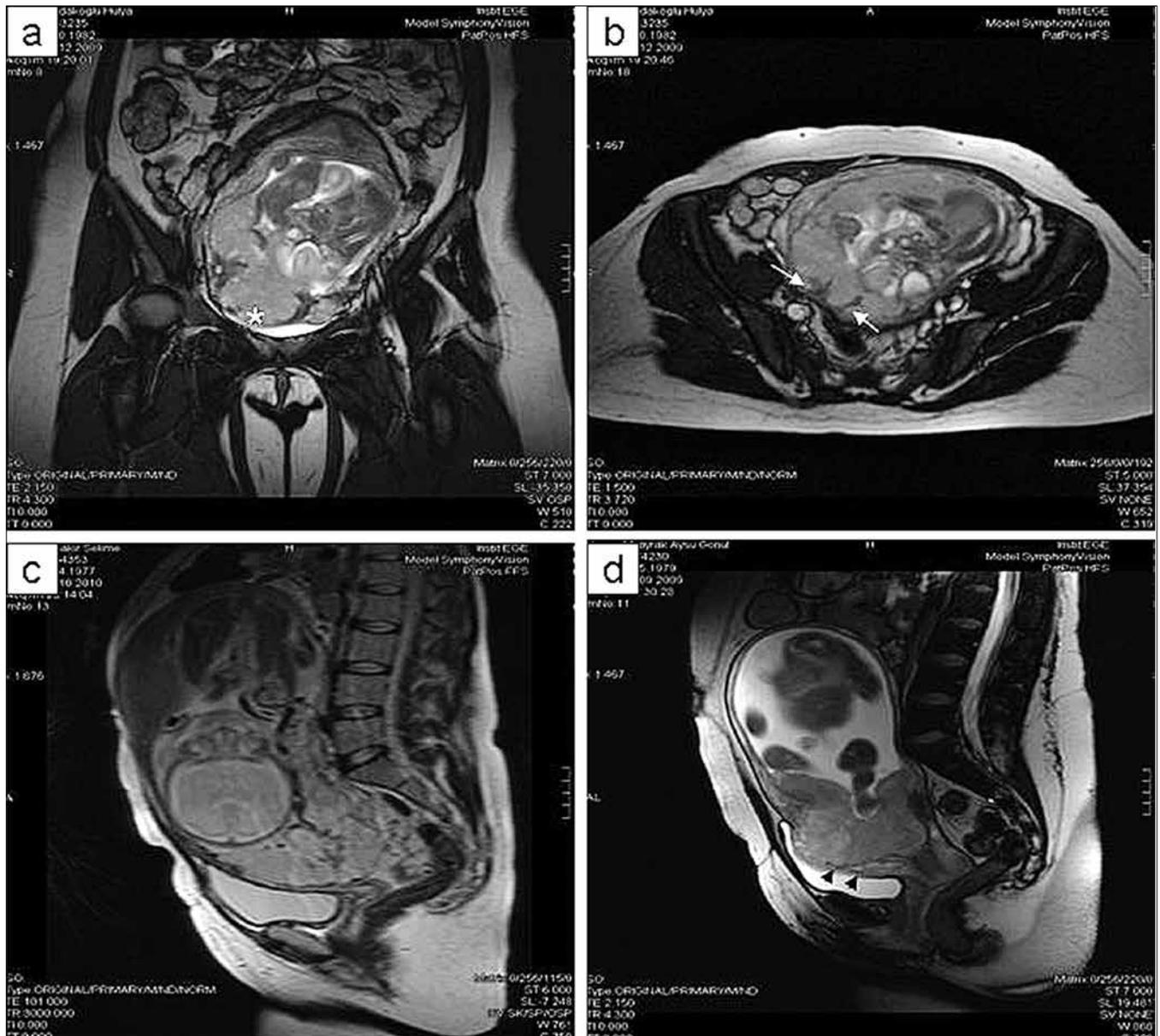
US and MRI assessment was performed in each case by the same obstetrician and radiologist. Unless patients had any complaints during or after the procedures, they were sent home on condition of a close follow-up. Patients with an overt bleeding or uterine contractions were hospitalized. Delivery was by elective CS under general anesthesia after careful preparation, with the availability of packed red blood cells and/or plasma

for transfusion. For patients who were considered highly likely to have placental adherence defect, the abdomen was entered through a subumbilical midline incision, while in others a Pfannenstiel incision was used. The uterus was entered through a vertical incision in the fundus. In patients whose placenta did not detached spontaneously, hysterectomy was performed to prevent heavy bleeding after having attempted to remove placenta manually. MRI and US results were compared with surgical and histopathological findings and the diagnostic efficacy of the methods was evaluated (Figure 3).

The histopathological findings were evaluated as: no adherence defects, placenta accreta, placenta increta and placenta percreta.

SPSS 15.0 for Windows was used for statistical analysis. Descriptive statistical methods, Student's t-test (the data within each group were normally distributed) and chi squared test were used.  $p < 0.05$  level was considered statistically significant. The results were expressed as mean  $\pm$  standard deviation.

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**Figure 2.** Abnormal uterine bulging (\*) on the coronal true-FISP image (a). Dark intraplacental bands (arrows) on the axial true-FISP image (b), heterogeneous signal intensity within the placenta on T2-weighted sagittal image (c), loss of the tissue plan between the placenta and bladder wall (arrows) on the sagittal image (True-FISP image).

## Results

Characteristics of the patients who had a confirmed placental adherence defect and underwent (n=20) post-CS hysterectomy and those who did not require the procedure (n=20) are shown in Table I.

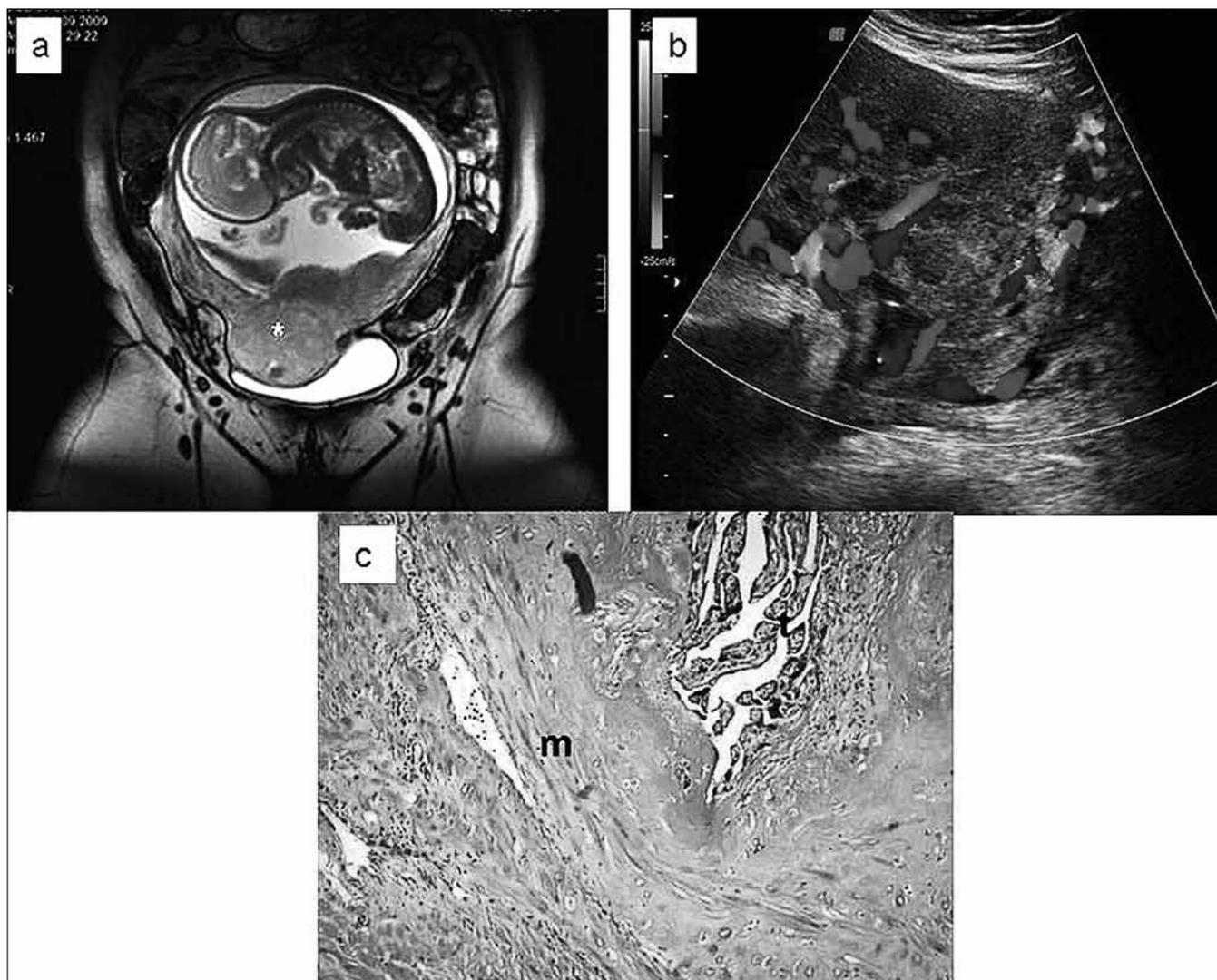
In case of the former, placenta accreta was confirmed in 10, placenta increta in 7, and placenta percreta in 3 patients by histopathological evaluation.

MRI prior to the operation did not suggest a placental adherence defect in 20 patients. In 19 cases, the placenta detached spontaneously at delivery, but in 1 case hysterectomy was required, with the pathological examination showing placenta accreta. In 20 patients placental adherence defects were

indicated by MRI. Post-CS hysterectomy was performed in 19 of these, while in one case the placenta detached spontaneously (no adherence defects).

Under ultrasonographic examination, grade 1 (n=8), grade 2 (n=2) and grade 3 (n=2) placental lacunae were detected in 12 patients. Post-CS hysterectomy was performed in all these women and placenta accreta was detected in 6, placenta increta in 4 and placenta percreta in 2 cases. Although placental lacunae were not detected, the placenta did not detach and hysterectomy was performed in 8 out of 20 patients because of placental adherence defect.

Sub-placental sonolucent spaces were considered to be normal in 30 and either abnormal or missing in 10 patients.



**Figure 3.** A patient diagnosed with placenta increta without bladder invasion has uterine bulging (\*) on the axial image (True-FISP) (a), abnormal vascularization between uterine serosa and bladder was explored under color Doppler US (b) and histopathology revealed placental adherence defect (t; trophoblast, m; myometrium) (c).

Post-partum hysterectomy was required in all of these women and after pathological examination, placenta accreta was found in 4, placenta increta in 4 and placenta percreta in 2 cases. In the 30 patients with normal sonolucent space, the placenta detached spontaneously in 20 and post-CS hysterectomy was performed in 10 cases.

The vesicouterine plane was assessed under US; and considered to be normal in 38 but abnormal in 2 patients. Post-CS hysterectomy was performed in these women and histopathology results revealed placenta increta. In 20 of 38 patients with regular vesicouterine plane, the placenta detached spontaneously, but hysterectomy was needed in 18 cases (3: placenta percreta, 5: placenta increta and 10: placenta accreta).

Grade 1, 2, 3 placental lacunae were detected in 12 patients under gray-scale US; and intra-placental lacunar turbulent blood flow with high-velocity was observed in 11 of these. Post-partum hysterectomy was performed in all cases.

Abnormal vascularization was detected in 8 women who were thought to have abnormal vascularization in the vesicouterine plane; intra-operative hysterectomy was performed in all. Post-Cesarean hysterectomy was performed in 12 of the 32 pregnant women in whom abnormal vascularization was not detected.

In the presence of at least one diagnostic criterion, the sensitivity and specificity of gray-scale US or color Doppler US, and the specificity, sensitivity, positive and negative predictive values of other warning criteria with regard to placental adherence defects are shown in Table II, while the surgical results are presented in Table III.

Bladder invasion was not detected in any of patients in this study.

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**Table I.** Characteristic features of patients with the diagnosis of placenta previa totalis

Number of patients (n=40)	PI accreta (-) (n=20)	PI accreta (+)* (n=20)	P value
Age / years	36±5.5	34.2±4.4	0.275
Gravidity	2.4±1.7	3.2±1.5	0.127
Parity	0.7±0.8	1.3±0.8	0.023
History of D&C procedures	0.3±0.47	0.3±0.48	0.744
History of CS	0.7±0.8	1.05±0.6	0.146

p was determined by Student's t-test and chi squared test

Abbreviations:

PI – Placenta (Values are given as mean ± SD, the difference were considered significant at p&lt;0.05 level.

\* Placenta accreta and its variants

**Table II.** Comparison of gray-scale, color Doppler, MRI criteria according to histopathologic results in patients diagnosed with placenta previa totalis

Patients diagnosed with placenta previa totalis (n=40)	Evaluation with MRI and US					
	PI acc* (+) (n)	PI acc (-) (n)	Sens (%)	Spec (%)	PPV (%)	NPV (%)
<b>Gray-scale US criteria</b>						
Subplacental sonolucent space	10	30	50	100	100	66,6
Bladder-uterine serosa border	2	38	10	100	100	52
Placental lacunae (grade 1,2,3)	12	28	60	71.4	100	71.4
<b>Color Doppler US criteria</b>						
Abnormal vascularization between the bladder and the uterus	8	32	40	100	100	62
Intra-placental lacunar turbulent blood flow	11	29	55	100	100	68
<b>MRI**</b>	20	20	95	95	95	95
<b>Color Doppler US ***</b>			62.5	100	100	72
<b>Gray-scale US ***</b>			87.5	100	100	88

\* placenta accreta and variants \*\* In 1 patient who was considered to have placenta accreta, placental adherence defect was not found while placenta accreta was not considered in 1 patient where the adherence defect was eventually detected..

\*\*\* In the presence of at least one diagnostic criterion

Abbreviations:

MRI – magnetic resonance imaging, sens – sensitivity; spec – specificity; NPV – negative predictive value, PPV – positive predictive value; US – ultrasonography

**Table III.** Surgical outcomes of patients with placenta previa totalis.

Placenta previa totalis	PI accrete (-) (n=20)	PI accrete (+) (n=20)	P value (n=40)
Birthweight (grams)	2854±338	2706±375	0.200
Gestational age at delivery (weeks)	37.1±0.5	36.4±0.9	0.162
Transfusion during and after surgery (units)	0.6±1.0	2.8±1.4	<0.001
Postoperative stay (days)	3.7±0.6	6.0±0.8	<0.001

p – was determined by Student's t-test and chi squared test

Values are given as mean± SD, the difference was considered significant at p&lt;0.05 level;

Abbreviations: PI – placenta

## Discussion

Steadily growing CS rates have led to an increased incidence of placental adherence defects. Their rate in women who have had one to five previous CS has been estimated as 15.6%, 23.5%, 29.4%, 33.3% and 50%, respectively [11].

In another placenta accreta series of 40 cases [12], the CS rate was 30% and total placenta previa was present in 17% of cases. Yet another trial of 32 cases of placenta accreta revealed the previous CS rate to be 78% and placenta previa was diagnosed in 88% of the patients [13]. In pregnant women who had two or more CS for placenta previa such adherence defects were observed in 40% of cases [14].

Masselli et al., [4] assessed 56 pregnant women with a total placenta previa and at least one previous CS by US and MRI. Both had similar results in establishing the diagnosis of placental adherence defects, whereas the depth of placental invasion was determined more precisely with MRI [15]. In the present study the sensitivity, specificity, positive and negative predictive values of MRI were 95%, and the depth of invasion did not fully match the histopathological findings.

Up to date, varying results have been obtained by assessment of placental lacunae. Masselli et al., [4] have stated that the most significant criterion in gray-scale US for the diagnosis of placental adherence defects is the observation of placental lacunae, with a sensitivity of 79% and positive predictive value of 92%. Shih et al., [16] reported that the sensitivity of this criterion was 54% with a specificity of 85%, while in the present study, they were found to be 60% and 71%, respectively.

Shih et al., [16] assessed the vesicouterine plane by gray-scale US and stated that this plane must be monitored regularly with hyperechogenicity as a criterion, but the sensitivity of this criterion was only 18%. No studies have shown that gray-scale US is of value for the assessment of the vesicouterine plane or for revealing bladder invasion [3-16-17]. Although this is in line with the present study, the evaluation of other criteria increase the usefulness of gray-scale US.

High negative predictive values ranging between 92%–100% in the assessment of intra-placental lacunar turbulent blood flow with high-velocity and abnormal vascularization between the bladder and uterus have been noted in recent studies [16-18-19]. Although that was not of great use in the present study, the importance of the negative predictive value increases when considering other criteria which have low positive predictive value for diagnosing placenta accreta and its variants. This will support clinicians in preparation for the operative procedure.

The main limitation of the present study was a relatively small number of cases and different gestational ages (28-34 weeks of pregnancy) at which the diagnosis was made. Assessment of more cases suspected of placental adherence defects with radiological methods may provide more reliable results to take pre-operative measures in the future.

## Conclusion

In conclusion, currently MRI appears to be the gold standard for the diagnosis of placenta accreta and its variants on condition its availability and costs are not taken into consideration. Despite the fact that no ultrasonographic criterion seems to be sufficient for establishing the diagnosis by itself, the authors consider that the criteria determined through gray-scale and color Doppler US

assist in the diagnosis. With the developments in 3-dimensional power Doppler US this may prove to be an important contribution to the diagnosis of placental adherence defects.

### Abbreviations:

- MRI – Magnetic resonance imaging
- NPV – negative predictive value
- PPV – positive predictive value
- US – ultrasonography

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