

Antepartum Evaluation of Placenta Accreta in Women with Placenta Previa by Color Doppler, Power Doppler Ultrasound and MRI: A Prospective Study

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Abstract

Background: Complications of placenta accreta include massive hemorrhage, damage to the uterus, bladder, ureters, and bowel, and often cesarean hysterectomy to control bleeding. Prenatal diagnosis of placenta accreta can help minimize the complication rate by enabling a surgeon to plan for the type of resources needed at the time of delivery.

Aim of Study: The aim of the study is to study the role of color Doppler, power Doppler ultrasound and MRI in diagnosis of placenta accreta and the accuracy of each method in diagnosis of the level of accretion.

Material and Methods: Fifty women with criteria of have low lying placenta or placenta previa, have at least one previous uterine scar, have mild or no vaginal bleeding underwent color Doppler ultrasound, power Doppler ultrasound and MRI study at 34-36 weeks gestation. The result of degree of accretion compared for each radiological method by that found intraoperative.

Results: Fifty pregnant women were included in this study, with a mean age 31.18 ± 3.88 . All patients proved by US to have placenta previa. Thirty two patients were diagnosed to be placenta accreta by color & power Doppler U/S, while 31 patient of the case were diagnosed to have placenta accreta by MRI. According to the pre-operative color & power Doppler and MRI findings and the intra-operative findings, color and power Doppler US has 96.4% sensitivity of in diagnosis of placenta accreta, while MRI has 82.1% sensitivity and combination of both imaging technique has the lowest sensitivity 78.6% but this combination has the highest specificity 90.9%, while MRI has the lowest specificity 63.6%.

Conclusion: Color and power Doppler abdominal U/S are more sensitive in diagnosis of placenta accreta (96.4%) than MRI (82.1%). The combination of color and power Doppler U/S and MRI has the highest specificity (90.9%).

Key Words: MRI – Ultrasound – Color Doppler – Placenta previa – Placenta accreta.

Introduction

PLACENTA accreta refers to an abnormal placental implantation in which the anchoring placental villi attach to the myometrium, rather than being contained by decidual cells leading to abnormal adherence to the uterine wall. Abnormal implantation includes, placenta increta; in which the chorionic villi invade into the myometrium and placenta percreta, in which the chorionic villi penetrate to or through the uterine serosa and can also invade the surrounding organ [1].

Clinical risk factors include placenta previa and previous uterine surgery, especially cesarean delivery at which the incidence of placenta accreta has increased with increasing number of cesarean deliveries [2]. Complications of placenta accreta include severe hemorrhage, uterine, urinary bladder, ureters, and bowel damage, even cesarean hysterectomy to control bleeding. Prenatal diagnosis of placenta accreta avoids the complication [3].

Color Doppler ultrasonography is available, non-invasive technique, and optimum to study the blood flow at the area of interest [4,5].

Power Doppler ultrasonography is a technique studying of blood flow more easier as it is angle independent and measures velocity directly without the Doppler shift principle [6].

Magnetic Resonance Imaging (MRI) provides detailed medical images in multi-planner sections without the use of ionizing radiation. It also has more benefits than other imaging modalities in obese women with redundant abdomen, besides; it provides a large sections of the body and lastly less operator dependent than ultrasonography [7].

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However, it is expensive, not universally available for routine use, and sometimes uncomfortable for the patient due to a relative long examination time [8].

Although MRI is difficult to be used as a screening tool for placenta accreta, it theoretically should be useful in determining which patients with obvious ultrasound evidence for placenta accreta have placenta percreta, and in confirming placenta accreta in those identified by ultrasound [9].

The aim of this study is to compare the color Doppler versus power Doppler ultrasound versus MRI in diagnosis and grading the severity of placenta accreta in women with placenta previa and antepartum hemorrhage, for better and optimal management of these high risk patients.

Patients and Methods

This prospective study was done within the period from December 2016 to December 2017. It was conducted on fifty pregnant women aged 23-38 years with a mean age 31.18 ± 3.88 . From those attending Department of Obstetrics and Gynecology outpatient clinics and emergency room and the radiological examinations included color Doppler, power Doppler and MRI examinations were done in the Radiology Department, Tanta University Hospitals. The patients were carefully selected according to the following inclusion criteria:

- Had low lying placenta or placenta previa detected by ultrasound.
- Had at least one previous uterine scar either cesarean scar or myomectomy scar.
- Patient in third trimester detected by detailed menstrual history with special emphasis on the last menstrual period, by early documented first trimester ultrasound or by third trimester serial ultrasound.
- Had mild or no vaginal bleeding and hemodynamically stable.
- Singleton pregnancy confirmed by ultrasound.

Exclusion criteria included patients who were hemodynamically unstable or contraindicated to MRI examination.

All patients submitted to the study had been counseled thoroughly about the procedure including its value and hazards, and the aim of the study and ethically accepted by the ethical committee. After this, a written consent had been obtained and signed by the patient and her husband.

These 50 pregnant patients subjected to:

- Full history taken, performing thorough general and abdominal examination, and obtaining routine investigations.
- Gray scale ultrasound to assure the location of the placenta and to assure the gestational age of fetus using 3.5MHz convex ultrasound prob. No previous patient preparation was needed.
- Color and power Doppler ultrasound at 34-36 weeks gestation, using Siemens Acuson X300 premium edition ultrasound. Placenta previa, placental lacunae, abnormal color Doppler imaging patterns, loss of the retroplacental clear space, and reduced myometrial thickness have all been described in placenta accreta. An irregular bladder wall has been described with placenta percreta.
- MRI at 34-36 weeks gestation, MRI unit 1.5-T system, using torso coil, were used for examination of the all patients. Pelvic scanning in axial, coronal, and sagittal planes. T1 WI, T2 WI sequences with thickness of 4 to 5mm; slice interval 2mm; 224 X 224 matrix; and a field of view of 420mm. The following criteria were used to diagnose placenta accreta;
 - Uterine bulging, disruption of the normal pear shape of the uterus, the lower uterine segment being wider than the fundus.
 - Heterogeneous signal intensity of the placenta.
 - Dark intraplacental bands (signal voids).
 - Focal interruptions of the myometrial wall.
 - In cases of placenta percreta, placental tissue can be seen extending through the myometrium with occasional invasion of surrounding structures.
 - Placenta directly invading or tenting the bladder is highly specific for placenta.

The imaging findings had been documented and preserved for the location of placenta and the degree of accretion of each placenta. The findings correlated with the monitored intraoperative findings regarding placental site, degree of placental attachment. Degree of intrapartum hemorrhage, surgical procedure done to stop bleeding if the case is accreta, any post-operative complications were noted and correlated with the ultrasound and MRI findings.

Placenta accreta was defined by clinical criteria at the time of delivery. The placenta was considered normal if it was easily removed during cesarean delivery without any bleeding complications. Ideally, the standard of reference for the diagnosis of

abnormal adherent placenta is confirmation of the final histology after hysterectomy. However, hysterectomy is not always clinically indicated or possible. Therefore, in these cases pathologic examination was not available and the diagnosis was based on clinical information provided at the time of delivery.

Results

This study included 50 pregnant women aged 23-38 years with a mean age 31.18 ± 3.88 . All of the included subjects had previous cesarean section scar, 17 out of 50 had single previous scar, 19 had two previous scars, 11 had three previous scars and 3 had six previous scars.

Gray scale routine ultrasonographic examination showed that all the included 50 pregnant women had placenta previa, 38 of them (76%) had placenta previa centralis, 10 patients had placenta previa marginalis and the remaining 4 patients had placenta previa lateralis. That majority of the patients were complaining from vaginal bleeding (52%), the other patients just come for routine antenatal care (48%).

There was a significant relation between the type of placenta previa and the complaint of the patient, with 96.4% of patients complaining from bleeding were diagnosed by gray scale U/S to have placenta previa centralis with p -value 0.001 (Table 1).

In this study 32 patients (64%) were diagnosed to be placenta accreta by color & power Doppler U/S, while 31 patient (62%) of the case were diagnosed to have placenta accreta by MRI, and 34% of the cases were diagnosed to have normal placental invasion by color & power Doppler U/S and while 38% of cases were diagnosed to have normal placental invasion by MRI (Table 2).

From 32 cases diagnosed to have placenta accreta by color & power Doppler only 8 cases has only one singe of placenta accreta 3 of them had placental lacunae, 4 of them had loss of retroplacental space, and one case has reduced myometrial thickness. And the other 24 case had more than two ultrasonographic finding as 18 patients had abnormal color Doppler imaging pattern with placental lacunae and turbulent flow.

From 31 cases diagnosed to have placenta accreta by MRI, all showed the signs of invasion with thinning of myometrium, while only 5 cases had shown the picture of bladder wall invasion.

The intra-operative data showed that 28 patients (56%) had placenta accrete while 22 patients (44%) diagnosed intraoperative to be not accreta. Five false positive case diagnosed by color Doppler US, they had single Doppler findings of suggesting accrete; one of them had reduced myometrial thickness, 3 cases had loss of retroplacental space, and one case had placental lacunae. While the eight false positive cases diagnosed on MRI were had myometrial thinning only.

According to the pre-operative color & power Doppler and MRI findings and the intra-operative findings, we concluded that color and power Doppler US has 96.4% sensitivity of in diagnosis of placenta accreta, while MRI has 82.1 % sensitivity and combination of both imaging technique has the lowest sensitivity 78.6%. But this combination has the highest specificity 90.9%, while MRI has the lowest specificity 63.6%. So the combination of both imaging technique has highest PPV (91.7%), but low NPV (76.9%), while color & power Doppler has the highest NPV (94.4%), but MRI has the lowest PPV and NPV (74.2%, 73.3%) (Tables 3,4).

Table (1): The relation of the type of Placenta Previa (PP) by gray scale U/S to the complaint of the patient.

Type of P.P	Complaint		Total
	Vaginal bleeding	Others	
<i>Centralis:</i>			
N	27	11	38
%	96.4%	50.0%	76.0%
<i>Marginalis:</i>			
N	1	9	10
%	3.6%	40.9%	20.0%
<i>Lateralis:</i>			
N	0	2	2
%	.0%	9.1%	4.0%
<i>Total:</i>			
N	28	22	50
%	100.0%	100.0%	100.0%
<i>Chi-square:</i>			
χ^2		14.627	
p -value		0.001*	

Table (2): Pre-operative diagnosis of placenta accreta by color & power Doppler and MRI.

	N	%
<i>Color & power Doppler:</i>		
Accreta	32	64
Not accrete	17	34
<i>MRI:</i>		
Accreta	31	62
Not accrete	19	38

Table (3): The relation of imaging technique to the intra-operative diagnosis of placenta accreta.

	T +ve	T -ve	F +ve	F -ve
Color, power Doppler	27	17	5	1
MRI	23	14	8	5
Color, power Doppler & MRI	22	20	2	6

Table (4): The value of imaging technique to the diagnosis of placenta accreta.

	Sensi- tivity	Speci- ficity	PPV	NPV	Accu- racy
Color, power Doppler	96.4	77.3	84.4	94.4	88
MRI	82.1	63.6	74.2	73.7	74
Color, power Doppler & MRI	78.6	90.9	91.7	76.9	84

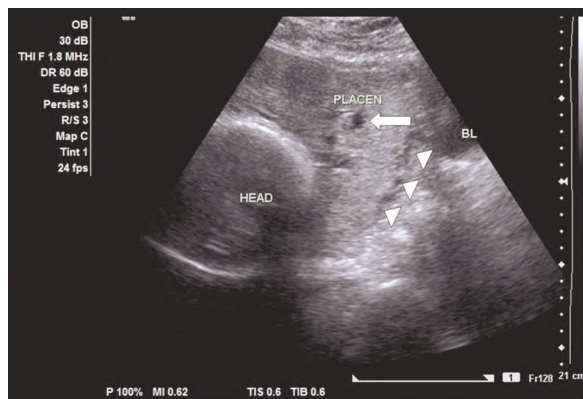


Fig. (1): A 30 years old female patient with placenta previa, gray scale ultrasound showed a placenta accrete, the placenta lacune (arrow) with focal absence of retroplacental hypoechoic zone (arrow heads).

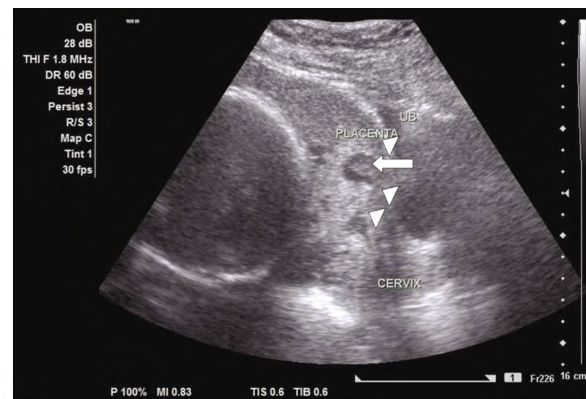


Fig. (2): A 29 years old female patient with placenta previa; gray scale ultrasound showed placenta accrete, the placenta lacune (arrow) with absence of retroplacental hypoechoic zone (arrow heads).

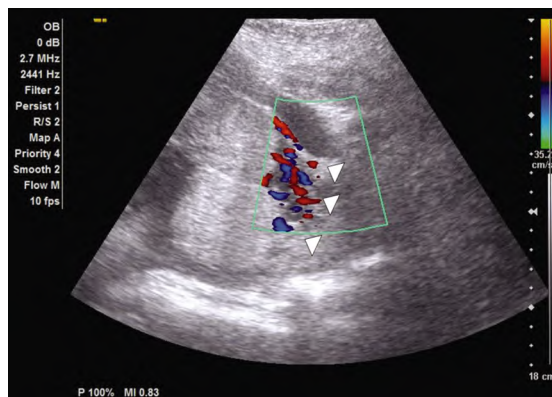


Fig. (3): A 30 years old female patient with placenta accrete, on color Doppler examination; abnormal hypervascularity at the placental myometrium interface (arrow heads).

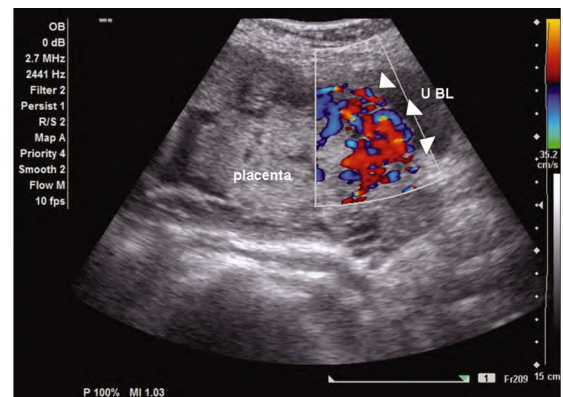


Fig. (4): A 32 years old female patient with placenta percreta, on color Doppler examination; abnormal hypervascularity at the placental myometrium interface extend beyond the myometrium to involve the urinary bladder wall (arrow heads).



Fig. (5): A 34 years old female patient with placenta accrete, MRI showed the placental invasion of the anterior uterine wall where the myometrium become quite thin and interrupted (arrow).

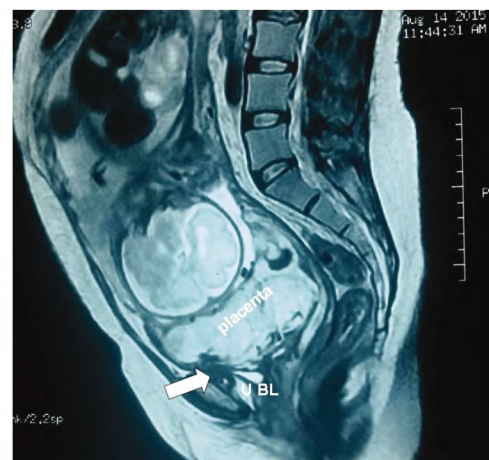


Fig. (6): A 32 years old female patient with placenta percreta, MRI showed the placental invasion of the anterior uterine wall where the myometrium is absent with invasion of the posterior urinary bladder wall (arrow).

Discussion

Placenta accreta refers to a placenta that is abnormally adherent to the uterus. When the placenta invades the myometrium, the term placenta increta is used, whereas placenta percreta refers to a placenta that has invaded through the myometrium and serosa, sometimes into adjacent organs, such as the bladder. The term placenta accreta is often used interchangeably as a general term to describe all of these conditions. It is important to make the diagnosis of placenta accreta prenatally because this allows effective management planning to minimize maternal morbidity and mortality [10].

Our study agreed with Ishan K. et al., (2016) who had compared the role of Doppler and MRI for evaluation of invasive placental disorders. Twenty-two patients underwent Doppler abdominal sonography and Magnetic Resonance Imaging (MRI). All the cases were correlated with surgical and pathological findings and they concluded that MRI and Doppler abdominal sonography are useful for detection of invasive placental disorders. However, the Doppler U/S was more accurate but MRI is a better predictor of bladder invasion [11].

Pilloni E. et al., [12] evaluated the accuracy of abdominal ultrasound in the diagnosis of placenta accreta and its variants, a total of 314 women with placenta previa were enrolled an abdominal ultrasound diagnosis (gray scale and color/power Doppler) of Placental Attachment Disorder (PAD) definitive diagnosis was made at delivery by cesarean section. They concluded that the color Doppler U/S had a sensitivity of 81.1% and specificity of 98.9%. Also Giulia G et al., [13] found that the results of diagnosis of placenta accreta with color Doppler examination had specificity 82% and sensitivity 97%.

Our study had different results with that study as the sensitivity is higher for color and power Doppler 96.4% and specificity is lower 77.3% as their study was conducted on larger number of cases, also their study depend on two ultrasound signs for diagnosis of placenta accreta making the diagnosis more specific but less sensitive.

Mi L et al., [14] evaluated the accuracy of abdominal ultrasound in the diagnosis of placenta accreta by meta-analysis study. A computerized literature search of PubMed and Chinese National Knowledge Infrastructure (CNKI) databases was conducted to identify relevant published articles on the diagnostic accuracy of ultrasound in detection placenta accreta. Two reviewers independently screened literature according to the inclusion and

exclusion criteria, extracted data, and assessed the quality. 28 eligible studies included 2847 patients at risk for placenta accreta were identified. The overall performance of ultrasound for the detection of the placenta accreta was as follows: The pooled sensitivity, 78% the pooled specificity, 94%; (LR+, 8.45; LR-, 0.25), and concluded that ultrasound has high accuracy for diagnosis of placenta accreta in high risk women. Our study had comparable results with that study as the sensitivity is higher for color and power Doppler 96.4% and specificity is lower 77.3%. As their study was conducted on larger number of studies and large number of cases.

Mawaldi L et al., [15] assessed the value of abdominal ultrasound in diagnosis of abnormal adherent placenta in third trimester of pregnancy, with a retrospective cohort observational study of 68 patients and to compare the finding with their finding of ultrasound antenatally, and the histopathology after surgery. And they found that the ultrasound findings revealed a sensitivity of 88.9%, and specificity of only 18.8%.

Our study had comparable results with that study as the sensitivity for color and power Doppler 96.4% but the specificity is much higher 77.3% as they evaluate every case retrograde after cesarean section according to the ultrasonic finding in the report, and this increase the missing signs of placenta accreta.

Our study harmonizes with Finberg and Williams [16] who were one of the first few investigators who evaluated the role of ultrasound in diagnosis of placenta previa accreta in patients with previous cesarean sections. By using only gray scale ultrasound. They found that ultrasound had a sensitivity of 93% and specificity of 79% in diagnosis of placenta accreta.

Our study agreed with Comstock [17] who said that grey-scale ultrasound is the first-line investigation for suspected placenta accreta, and the most sensitive diagnostic criteria are irregular shaped placental lacunae within placental. This feature has sensitivity 79% at 15 to 20 gestational weeks and sensitivity 93% after 20 weeks gestation, its positive predictive value is up to 92%. The second diagnostic criteria is loss of retro placental clear space with 80% sensitivity.

Our study agreed with Yoshiko U. et al., [18] reviewed MR findings for the diagnosis of invasive placenta previa, with prenatal MRI examinations of 65 patients (median age: 35 years). All MRIs were performed on a 1.5-T unit, including axial, coronal and sagittal T2-weighted half-Fourier

single-shot turbo spin echo imaging. And they found that intraplacental abnormal vascularity, uterine bulging, heterogeneous placenta and placental protrusion sign. All can be used reliably in diagnosis of placenta accreta.

Kenji T. et al., [19] studied on 58 pregnant women with placenta previa using both abdominal ultrasonography and magnetic resonance imaging prenatally and they concluded that US findings, especially loss of retroplacental hypoechoic clear zone, with ($p < 0.01$) might be useful for identifying patients at high risk for adherent placenta among pregnant women with placenta previa. Our study agrees with the importance of gray scale ultrasound and MRI in diagnosis of accreta, but we found three false positive cases with loss of retroplacental clear zone, and the use of power and color Doppler will increase the accuracy for diagnosis of placenta accreta.

Daney De Marcillac F. et al., [20] had compared accuracy of abdominal ultrasonography and MRI for antenatal diagnosis of placenta accreta. And also tried to specify the most common sonographic and MRI signs associated with diagnosis of placenta accreta. They conducted their study over twenty-two potential cases of placenta accreta and they concluded that sensitivity and specificity for ultrasonography were 92% and 67%, respectively and for MRI 84% and 78% respectively. The most relevant signs associated with diagnosis of placenta accreta in ultrasonography were increased vascularity on color Doppler, abnormal placental lacunae and loss of retroplacental clear space. The most relevant signs in MRI were: Abnormal uterine bulging, dark intraplacental bands on T2-weighted images or placental heterogeneity. And the association of two sonographic or MRI signs had the best sensitivity/specificity ratio. Our study had a comparable result with color Doppler more accurate in diagnosis of placenta accreta than MRI, also no cases with abnormal vascularity on color Doppler had false positive result, and the MRI finding also comparable.

Our study agreed with Bonnie K. et al., [21] had compared the accuracy of transabdominal sonography and Magnetic Resonance Imaging (MRI) for prenatal diagnosis of placenta accreta over 32 patients they concluded that sonography had (93% sensitivity; 71% specificity). Magnetic resonance imaging had (80% sensitivity and 65% specificity), so both sonography and MRI have fairly good sensitivity for prenatal diagnosis of placenta accreta; however, specificity does not appear to be as good as reported in other studies.

Our study harmonizes with Levine D. et al., [6] who had determined the value of transabdominal ultrasound, transvaginal US, color Doppler US, power Doppler US, and Magnetic Resonance (MR) imaging in the diagnosis of placenta accreta. Over Nineteen patients in the third trimester of pregnancy who were at risk for placenta accreta, and they found that in patients with a history of uterine scars, vaginal US with power Doppler US performed well in the evaluation of lower-uterine-segment placenta accreta. MR imaging depicts posterior placenta accreta.

Warshak et al., [22] had a historical cohort study to determine the accuracy of abdominal U/S in the diagnosis of placenta accreta. The records of those considered to be suspicious for placenta accreta and subsequently referred for additional confirmation by MRI were also analyzed. The abdominal sonographic and MRI diagnosis were compared with the final pathologic or operative findings or with both. Abdominal ultrasonography accurately predicted placenta accreta in 30 of 39 of women and correctly ruled out placenta accreta in 398 of 414 without placenta accreta (sensitivity 77%, specificity 96%). Forty-two women underwent MRI evaluation because of findings suspicious or inconclusive of placenta accreta by ultrasonography. Magnetic resonance imaging accurately predicted placenta accreta in 23 of 26 cases with placenta accreta and correctly ruled out placenta accreta in 14 of 14 (sensitivity 88%, specificity 100%).

Our study had different results as the sensitivity is higher for color and power Doppler 96.4% but the specificity is much lower 77.3%. Also MRI had comparable sensitivity 82.1% but lower specificity 63.3% and this may be due to larger number of patients used.

Conclusion:

There is significant relation between the type of placenta previa and the complaint of the patient, majority of patients complaining from vaginal bleeding were diagnosed by gray scale abdominal U/S to have placenta previa centralis. Color and power Doppler abdominal U/S are more sensitive in diagnosis of placenta accreta (96.4%) than MRI (82.1%) and combination of both imaging technique (78.6%). The combination of color and power Doppler U/S and MRI has the highest specificity (90.9%). Color & power Doppler is the most accurate for diagnosis of placenta accreta with accuracy 88%. MRI had lower accuracy than Doppler U/S in diagnosis of placenta accrete with accuracy 74%.

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تقييم حالات إلتصاق المشيمة فى حالات المشيمة المعيبة أثناء الحمل بإستخدام الدوبلر الملون والدوبلر المقوى والرنين المغناطيسى؛ دراسة مستقبلية

الغرض من هذه الدراسة هو دراسة دور الدوبلر الملون والدوبلر المقوى والتصوير بالرنين المغناطيسى فى تشخيص المشيمة المعيبة ودقة كل طريقة فى تشخيص مستوى التراكم.

وشملت المواد والطرق خمسون امرأة مع تعانى من إنخفاض المشيمة أو المشيمة المنزاحة، ولديها ندبة رحم سابقة واحدة على الأقل، وخضعت لنزيف مهبلى بسيط أو بدون. تم عمل فحص بالدوبلر الملون والدوبلر المقوى وكذلك فحص بالرنين المغناطيسى عند ٣٤-٣٦ إسبوعاً من الحمل وتم مقارنة النتائج بكل طريقة فحص بالنتائج التى وجدت أثناء العملية الجراحية.

وشملت نتائج هذه الدراسة خمسون امرأة حامل، بمتوسط عمر ٣١.١٨±٢.٨٨ سنة وكانوا يعانون من مشيمة منخفضة تم تشخيصهم بالموجات فوق الصوتية. تم تشخيص إثنين وثلاثين مريضة لديها مشيمة معيبة عن طريق الدوبلر والدوبلر المقوى، فى حين تم تشخيص ٣١ مريضة لديها مشيمة معيبة بواسطة التصوير بالرنين المغناطيسى.

وفقاً لنتائج العمليات الجراحية وجد أن الدوبلر الملون والدوبلر المقوى يتمتع بحساسية تبلغ ٩٦.٤٪ فى تشخيص المشيمة المعيبة، بينما كان الفحص بالرنين المغناطيسى له حساسية تبلغ ٨٢.١٪ وعند دمج الثلاث تقنيات من التصوير كانت لهم أقل حساسية ٧٨.٦٪ ولكن هذا المزيج كان لديه أعلى خصوصية ٩٠.٩٪، فى حين أن التصوير بالرنين المغناطيسى لديه أدنى خصوصية ٦٣.٦٪.

والخلاصة أن الدوبلر الملون والدوبلر المقوى هو أكثر حساسية فى تشخيص المشيمة المعيبة، وأن الدمج مع الفحص بالرنين المغناطيسى يكون لديهم أعلى خصوصية.