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ORIGINAL ARTICLE

Retrospective Comparison of Ultrasound and Magnetic Resonance Imaging as Diagnostic Tools in Pregnant Women with Abnormal Placentation

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ABSTRACT

Postpartum hemorrhage is the leading cause of maternal death worldwide, and Placenta Accreta (PA) is a major contributor. Although advancements in obstetric practices have led to a decline in maternal mortality, PA remains challenging to diagnose and manage. Current diagnostic tools include ultrasound (U/S) and Magnetic Resonance Imaging (MRI); however, the sensitivity and specificity of these techniques in diagnosing Placenta Accreta Spectrum (PAS) are widely debated.

Objective: To compare the accuracy of U/S and MRI in the diagnosis of PAS.

Methods: A retrospective analysis of pregnant women in their second and third trimesters suspected to have PAS was conducted. Women with both antenatal U/S and MRI who delivered in Dr. Soliman Fakeeh Hospital between 1st October 2014 and 2nd February 2019 were included.

Results: Of the 46 women included in the study, MRI corrected the diagnosis of 13 patients (28%) and confirmed the U/S diagnosis of 19 patients (41%). However, MRI also resulted in an incorrect change in diagnosis of eight patients (17%), and an incorrect confirmation of U/S diagnosis of six patients (13%). Statistical analyses of both U/S and MRI in the diagnosis of PAS showed that U/S sensitivity and specificity were 40% and 75%, respectively, whereas MRI sensitivity and specificity were 86% and 58%, respectively.

Conclusion: MRI was more sensitive than U/S in identifying placental invasion into the uterine wall. Therefore, we recommend MRI examination for all patients suspected to have PAS.

Keywords: Abnormal placentation, magnetic resonance imaging (MRI), placenta accreta spectrum, ultrasound, prenatal diagnosis, surgical findings, histopathology.

INTRODUCTION

According to the World Health Organization (WHO), postpartum hemorrhage is the major cause of maternal death worldwide [1]. Although there are many causes of postpartum hemorrhage, abnormal placentation is one of the most serious. An excessively firm attachment of placental villi to the uterine wall, without the normal intervening decidua basalis and Nitabuch fibrinoid layer, is known as placenta accreta (PA). PA has been linked to high rates of death and morbidity, mostly as a result of blood loss that cannot be controlled [2]. At the beginning of the 19th century, the incidence of PA was one in 30,000 deliveries. This incidence rate rose at the beginning of the 20th century to one in every 700 deliveries, which coincided with an increase in cesarean sections worldwide [2, 3].

Advancements in obstetric practices and diagnostics have reduce the incidence of maternal mortality [4]. However, placenta accreta spectrum (PAS) is still challenging to diagnose and manage [5]. More effective care can be achieved if afflicted pregnancies are diagnosed during pregnancy. The interdisciplinary approach for high-risk patients includes the obstetrician, gynecological surgery team, urological surgery team, anesthesiologist team, and blood banks. Indeed, these multidisciplinary approaches have substantially decreased the risk of maternal morbidity and mortality [4, 5].

Ultrasound (U/S) is the primary modality for placental assessment to diagnose PAS. It is a user-friendly, non-invasive, and cost-effective tool that can lead to an accurate diagnosis within a short examination time. Although the sensitivity and specificity of U/S can be high, these factors are operator-dependent. Moreover, there are other factors that may affect the sensitivity and specificity of U/S, including the scanning conditions (e.g., fetal position and presentation) and gestational age [6, 7].

In addition to U/S, magnetic resonance imaging (MRI) is a useful modality to assess abnormal placentation. MRI is accurate and safe enough to perform during pregnancy. The use of MRI to diagnose placental invasion can alter the diagnosis of the obstetrician and the ensuing management plan. For example, in a 2018 study of 78 patients diagnosed with PA based on U/S, a subsequent prenatal placental MRI evaluation resulted in incorrect diagnoses in 38% of the cases. [8]. In fact, significant variations in the sensitivity and specificity of MRI to diagnose abnormal placentation have been reported. These variations can be mitigated by the combination of MRI and U/S, as observed in a study in which the addition of MRI to U/S resulted in an increase in the sensitivity of U/S and MRI diagnosis from 86% and 92% respectively to 100% [9]. In contrast, another study demonstrated low sensitivity for MRI and 33% for U/S [10]. Unfortunately, the value of these studies is limited by low sample sizes of 19 and 13 patients, respectively.

In a meta-analysis of over 20 studies and 1,080 patients with expected PAS, MRI diagnosed PAS with high sensitivity and specificity. The sample underwent secondary MRI after primary U/S for evaluation of the placenta. MRI exhibited high sensitivities of 94.4%, 100%, and 86.5% for PA, increta, and percreta, respectively, and specificities of 98.8%, 97.3%, and 96.8% for PA, placenta increta (PI), and placenta percreta (PP) respectively. It was also noted that MRI accuracy may be affected by patient risk factors [7]. In the light of conflicting evidence regarding the role of MRI in diagnosing PAS, we sought to determine and compare the diagnostic accuracy of MRI and U/S in the diagnosis of PAS.

PATIENTS AND METHODS

Pregnant women who were beyond 24 weeks of gestational age with placenta previa and were suspected to have PAS were included in this retrospective cohort study. The study was conducted at Dr. Soliman Fakeeh Hospital, which is a tertiary hospital, medical college (physician and nursing), and postgraduate residency center. Women were enrolled in the study from the 1st of October 2014 until the 2nd of February 2019. Any pregnant women who were beyond 24 weeks of gestation and had persistent placenta previa (placenta remains over or reaching the internal cervical os) or anterior low lying placenta (placental edge lies within 2 cm of the internal cervical os) with suspicion of PAS (placental accreta or focal accreta, increta, and percreta) by U/S or clinical risk factors (e.g. previous Cesarean delivery) were included in the study. As part of the inclusion criteria, both antenatal U/S and MRI had to be performed inside the institute. Any patient lacking an imaging modality inside the institute, lacking documentation or data, or who delivered outside the institute was excluded. Cases with low lying placenta that became normally

implanted or posterior low-lying placenta that did not cross the internal os were also excluded.

After obtaining approval from the Institutional Review Board, cases were collected through a clinical database search using the following the International Classification of Diseases : placenta previa with hemorrhage, second trimester; placenta previa with hemorrhage, third trimester; placenta previa specified as W/O hemorrhage, second trimester; and placenta previa specified as W/O hemorrhage, third trimester. U/S and MRI reports were retrieved from the radiology data system. Sonographic features that were considered suggestive of PAS included multiple placental vascular lacunae, loss of the retro placental hypoechoic clear zone, myometrial thinning, placental bulge, disruption of the bladder wall uterine interface, exophytic mass, and abnormal vascularity on color Doppler imaging. Based on the presence or absence of these criteria, each case was designated positive or negative for PAS.

A total of 78 patients were identified with at least one diagnosis of placenta previa. Forty-two patients were excluded from the study; 33 patients had only an U/S, two patients had only an MRI, six patients delivered outside of the hospital, and one patient had an original diagnosis of anterior low lying placenta but became normally implanted placenta with continuation of pregnancy and delivered vaginally. Antenatal care electronic records and inpatient medical files were reviewed to obtain information about age, BMI, gravidity, parity, gestational age, past medical history, past obstetric history, past surgical history, intraoperative findings, and histopathology reports, when available (Table 1).

Without intravenous contrast, MRI was done in orthogonal planes across the uterus using both T1- and T2-weighted sequences. Imaging was performed and interpreted by a minimum of six different radiologists to avoid personal bias. U/S and MRI findings were compared with a histopathology examination whenever hysterectomy was performed. Histopathology is the gold standard for diagnosis of PAS. In the cases lacking histopathology, comparisons were made to the clinical diagnosis of the surgeon (consultant, M.D. certified). The clinical criteria considered by the surgeon included difficult manual extraction of the placenta; abnormal focally adherent placenta which was managed by surgical suturing of the placental bed or excision of the adherent placental tissue with uterine wall defect repair.

Statistical analysis: A statistical tool for social science, SPSS, was used to examine the data. Numbers and percentages were used to represent qualitative data. Qualitative data were tested for significance using chi-squared tests. Significance was considered at a p value≤ 0.05. Measurements of accuracy and overall predictability were calculated as well.

RESULTS

A total of 46 women suspected to have abnormal placentation were included in this retrospective study. All patients underwent antenatal U/S and MRI. U/S identified PA in 15 patients, and 9 of these patients were confirmed to have PAS by surgical or histopathological findings. Table 2 classifies the study participants according to clinical and histopathological assessment. Hysterectomy was performed in 23.9% of cases. Only 47.8% of the cases included in this study were suspected to have PA; however, on assessment, only 21.7% exhibited clinical characteristics of PA. Moreover, only 26.1% showed histopathological characteristics of PA. Thirty-one (31) patients were not diagnosed with PA based on U/S examination, and 18 of these patients did not show evidence of PAS in surgery or pathology. However, 13 patients did show evidence of PA. U/S examination showed a sensitivity of 40% and a specificity of 75% (Table 3).

However, MRI data also led to an incorrect diagnostic change in eight patients and an incorrect confirmation of U/S diagnosis in six patients when compared to U/S, MRI results properly changed the diagnosis in 13 and correctly confirmed the diagnosis in 19 (Table 3). MRI identified PA in 29 patients, and 19 of these patients were confirmed to have PAS by surgical or pathological findings. PA was excluded as a diagnosis by MRI in 17 patients, and 14 of these patients did not present surgical or pathological findings of PAS. MRI had a sensitivity of 86% and a specificity 58% (Table 4).

Table 1: Demographic data of the study participants with placenta previa

Variables	Frequency	Percentage
Age Mean Range	 32.3 ± 12.6 (24 – 48)	
Parity Median Range P1 P2 P3 p4 P5 P6	 3 (1 – 6) 5 13 13 7 5 3	 10.8 28.2 28.2 15.2 10.8 6.5
Number of Previous Cesarean Median Range 0 1 2 3 4 5	 2 (0 – 5) 3 5 15 10 8 5	 6.5 10.8 32.6 21.7 17.4 10.8
Placental Location Anterior Posterior	 34 12	 73.9 26.1

Table 2: Clinical characteristics and histopathology outcomes

Clinical Finding	Frequency	Percentage
No accreta	24	52.2
Accreta	22	47.8
Hysterectomy	11	23.9
Clinical characteristics of PAS	10	21.7
Histopathology evidence of PAS	12	26.1

Table 3: Accuracy of U/S in the diagnosis of abnormal placentation

Surgical diagnosis U/S diagnosis	Pregnant female with abnormal placentation	Pregnant female with normal placentation	Total
Positive	9	6	15
Negative	13	18	31
Total	22	24	46
Sensitivity	40.9%		
Specificity	75%		
Accuracy	58.6%		
Positive predictive value	60%		
Negative predictive value	58%		

Table 4: Accuracy of MRI in the diagnosis of abnormal placentation

Surgical diagnosis MRI diagnosis	Pregnancy with abnormal placentation	Pregnancy with normal placentation	Total
Positive	19	10	29
Negative	3	14	17
Total	22	24	46
Sensitivity	86.3%		
Specificity	58.3%		
Accuracy	71.7%		
Positive predictive value	65.5%		
Negative predictive value	82.3%		

A comparison of MRI and ultrasound in the diagnosis of aberrant placentation is presented in Table 5. Both modalities were shown to differ significantly in their degree of specificity, as demonstrated by our findings, indicating that MRI diagnosis was

more sensitive than U/S diagnosis (p≤ 0.001); however, we also found that U/S diagnosis was significantly more specific (p = 0.013). Moreover, the negative predictive value of MRI diagnosis was significantly higher than U/S diagnosis, whereas U/S diagnosis recorded significantly higher false positive rates (p≤ 0.001). Prevalence of correct and wrong diagnoses and comparisons of U/S and MRI results regarding the diagnosis of abnormal placentation are shown in table 5.

Table 5: Diagnostic accuracy of U/S and MRI

Diagnostic	U/S diagnosis Parameters	MRI diagnosis parameters	Test of significance
Sensitivity	40.9%	86.3%	Chi-square = 45.39 p≤ 0.001
Specificity	75%	58.3%	Chi-square = 6.49 p = 0.0 13
Accuracy	58.6%	71.7%	Chi-square = 3.65 p = 0.0 54
Positive predictive value	60%	65.5%	Chi-square = 0.53 p = 0.46
Negative predictive value	58%	82.3%	Chi-square = 13.72 p≤ 0.0 01

Concordance rate between U/S and MRI:

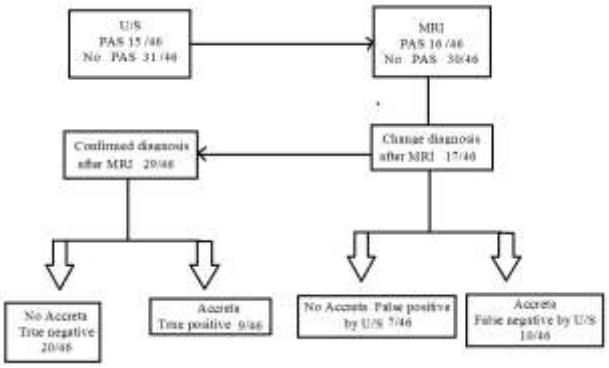

Figure 1: Concordance rate between U/S and MRI

The concordance rate between U/S and MRI in this study was 29/46 (63%). Of the patients with concordant diagnoses, 9/46 (19.5%) had PA, and 20/46 (43.7%) did not. The false positive rate of U/S diagnosis was 10/46 (21.7 %), and the false negative rate was 7/46 (14.8) in relation to MRI diagnosis (Figure 1).

DISCUSSION

Recent obstetrical advancements in U/S imaging and multidisciplinary approaches to PAS have greatly improved; however, PAS remains a challenging diagnosis and a high-risk event [8]. Importantly, accurate prenatal diagnosis enables proper planning with a multidisciplinary team. The sensitivity and specificity of U/S and MRI in identifying placental invasion into the uterine wall have been evaluated with varying results. For example, one meta-analysis suggested that U/S had a sensitivity of 90%, which is contrasted by another study in which U/S showed a sensitivity of only 53% [6,13]. In this study, we showed an U/S sensitivity of 40% and a specificity of 75%. U/S failed to diagnose 19 patients with PAS. Interestingly, three of these patients were obese (BMI>30), and three had posterior placenta previa, which are both factors known to affect U/S sensitivity.

Although our study found MRI to have a sensitivity of 86% in the diagnosis of PAS, D' Antonio and colleagues reported that MRI sensitivity can reach 94%. This difference may be due to the wide variability between the sample sizes included in both studies: 1,010 patients in the review by D' Antonio et al. and 46 cases in the present study. Moreover, we propose that other factors may contribute to such a difference, including the use of contrast, gestational age at diagnosis, and the radiologist expertise in diagnosing PAS. As we cannot reach a consensus based on this study, additional studies are required to define MRI accuracy [13].

There is no written protocol delineating the management plan of suspected PAS at Dr. Soliman Fakeeh Hospital. Therefore, management decisions and the use of MRI are the responsibility of the primary clinician after a consultation with a multidisciplinary team. Although U/S and MRI have been reported to identify placental invasion at comparable rates, the effect of MRI results on the management plan for these patients remains unknown [11,12]. Here, we attempted to address this uncertainty and found that MRI confirmation of placental invasion gave our team enough time to prepare for anesthesia, blood loss, and a multidisciplinary team approach. Of note, we did not report any cases of maternal mortality in this study. In our center, seventy-eight cases were suspected of abnormal placentation between 1 October 2014 and 2 February 2019. In this period of almost 5 years, less than two patients were suspected to have abnormal placentation per month. Thus, the use of both U/S and MRI to evaluate high-risk PAS patients may be reasonable in light of planning for management, availability of resources, and a qualified multidisciplinary team.

CONCLUSIONS

MRI was more accurate than U/S in identifying placental invasion to the uterine wall. We recommend that patients diagnosed with PAS by U/S undergo an additional MRI examination to prepare the best management plan options for high-risk patients.

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