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Prenatal Detection of Placenta Accreta: A Comparison of Doppler Ultrasound and MRI

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ABSTRACT

Placenta accreta is a severe maternal complication where the placenta abnormally attaches to the uterine wall, causing significant maternal and neonatal morbidity. **Objectives:** To compare the effectiveness of Doppler ultrasound and magnetic resonance imaging in the early detection of placenta accreta and their impact on maternal and fetal outcomes. **Methods:** Using purposive sampling, 150 high-risk pregnant women were screened with Colour Doppler Ultrasonography and magnetic resonance imaging. Findings were confirmed at delivery. Maternal outcomes included blood transfusion, emergency hysterectomy, intensive care unit admission, and hospital stay. Fetal outcomes included preterm birth, low birth weight, and neonatal intensive care unit, admission. Sensitivity, specificity, positive, and negative predictive values were calculated. Mc-Nemar's test compared modalities. **Results:** Of 150 patients, 74 had placenta accreta. Colour-Doppler ultrasonography had a sensitivity of 86.5% and specificity of 89.1%, diagnosing 64 cases. Magnetic resonance imaging showed 79.7% sensitivity and 83.3% specificity, identifying 59 cases. Colour-Doppler ultrasonography was linked to fewer emergency hysterectomies (p=0.032) and shorter intensive care unit stays (p=0.045). Preterm birth (p=0.028) and low birth weight (p=0.037) were higher in placenta accreta cases diagnosed with antepartum, though neonatal intensive care unit, admissions did not differ (p=0.451). Magnetic resonance imaging helped in inconclusive Colour-Doppler ultrasonography cases. **Conclusions:** It was concluded that Colour-Doppler ultrasonography is more effective than magnetic resonance imaging for early Placenta accreta detection, offering better diagnostic accuracy and improved outcomes. The findings highlight its value in the clinical management of high-risk pregnancies.

INTRODUCTION

A pregnancy issue known as placenta accreta (PA) arises when the chorionic villi intrude into the myometrium. It is linked to severe peripartum hemorrhage-related maternal morbidity and mortality [1]. The two primary risk factors for PA are placenta previa and a history of caesarean birth; the prevalence of PA rises exponentially with the number of caesarean sections performed [2, 3]. It has been demonstrated that if PA is diagnosed before delivery, morbidity can be considerably decreased [4, 5]. Using magnetic resonance imaging (MRI) or ultrasound as a means of systematic screening and diagnosis of PA would enable high-risk pregnant women to be referred to tertiary hospitals that have specialized multidisciplinary teams with experience managing pregnancies affected by PA [6]. Additionally, thromboembolism and hospitalisation to the critical care unit are risks that are higher for patients with PA. It has been estimated that 7% of maternal deaths are related to PA [7]. Utilising methods like magnetic resonance imaging (MRI) and ultrasound to check the foetus can help prevent issues connected to PA by facilitating safe delivery and surgical planning [8]. One useful tool for diagnosing PA is ultrasound. Pregnancy-related PA monitoring and prompt identification of placental invasion are made possible by the non-invasive ultrasound examination, which can be done multiple times. The placenta's posterior positioning and the patient's body

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composition can both have an impact on the ultrasound examiner's performance, which is dependent on their prior experience [9, 10]. MRI can be used in place of or in addition to ultrasound for the diagnosis and monitoring of PA [11] to get around some of the limitations of ultrasound. With MRI, permanent digital images can be acquired without the real-time execution issues that are usually present with ultrasound. Still, there are ongoing worries about fetal safety, and a contrast medium might be needed. Despite these reservations, MRI has become more often utilized in prenatal care for patients with PA, especially to assess the depth of invasion and disease extent [12]. Although PA has been diagnosed in utero using both MRI and ultrasound, the precision of these two imaging modalities is yet unknown. There are still several unsolved questions concerning the use of MRI and ultrasonography in PA patients. As an example, reports on their diagnostic accuracy vary [13]. The use of MRI or ultrasound in PA has since been the subject of reports from several different research groups [14]. The woman is more likely to experience potentially fatal bleeding and surgical complications, such as damage to the ureters and bladder, if placenta accreta is not diagnosed during pregnancy [15].

This study aims to assess the early diagnosis of PA using MRI and ultrasonography and its impact on fetal and maternal outcomes.

METHODS

This cross-sectional study was carried out over one year, from January 2023 to December 2023, and enrolled a total of 150 pregnant women considered at high clinical risk for placenta accreta. The study was taken place at Social Security Teaching Hospital Lahore after getting approval from the Institutional Review Board (Reference number: 16/2022). The sample size was calculated to achieve adequate power for comparing the diagnostic sensitivity and specificity of prenatal Doppler ultrasound and MRI. The sample size was calculated using the following formula for diagnostic test studies: $n=Z2a/2\times P\times(1-P)/d2$. Where: $Z\alpha/2$ the critical value corresponding to the desired confidence level (1.96 for 95% confidence), P is the expected prevalence or sensitivity of the diagnostic test (assumed to be 90% for Doppler ultrasound and MRI based on previous studies) [16], d is the desired precision or margin of error (set at 5%). The calculation yielded a minimum sample size of approximately 138 participants. To account for potential dropouts and incomplete data, the sample size was increased to 150 participants, in line with dropout rates of 5–8% reported in similar studies [17]. Inclusion criteria comprised of pregnant women between 20 and 36 weeks of gestation, identified as high-risk for placenta accreta based on clinical factors such as prior cesarean sections, uterine surgeries, or presence of placenta previa on ultrasound. Women with contraindications to MRI or pregnancies with severe fetal anomalies were excluded. Each participant after taking a written informed consent for the inclusion in study, underwent both Doppler ultrasound and MRI for prenatal screening. Doppler ultrasound was performed using a Philips Enterprise Platform for Integrated Quality (EPIQ) 7 system, employing grayscale imaging and colour Doppler to assess placental anatomy, vascularity, and myometrial thickness. MRI scans were performed using a 1.5-T MRI scanner (Philips Ingenia), acquiring T2-weighted images in sagittal, coronal, and axial planes, with a focus on detecting abnormal placental invasion. MRI sequences were interpreted by a radiologist with 10 years of experience. Maternal outcomes, including blood transfusion requirements, emergency hysterectomy, intensive care unit (ICU) admission, and duration of postpartum stay, were recorded. Fetal outcomes such as preterm birth, low birth weight, and neonatal intensive care unit (NICU) admission were also documented. Placenta accreta, increta, or percreta were confirmed at delivery and/or through histopathological examination. SPSS version 25.0 was used for data analysis. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated for Doppler ultrasound and MRI and compared using the McNemar test. Potential confounders, including gestational age, parity, and prior uterine surgeries, were controlled through multivariate logistic regression. Maternal and fetal outcomes were analyzed using independent t-tests for continuous variables and chi-square tests for categorical variables, ensuring that assumptions for the McNemar test were met.

RESULTS

The diagnostic performance of Doppler ultrasound and MRI is summarized. Doppler ultrasound demonstrated a sensitivity of 86.5% and specificity of 89.1%, correctly identifying 64 of the 74 confirmed cases of placenta accreta. MRI, in comparison, showed a sensitivity of 79.7% and specificity of 83.3%, accurately diagnosing 59 cases. Doppler ultrasound had 10 false-negative and 8 false-positive cases, whereas MRI had 15 false-negative and 13 false-positive cases. P-values for the comparison of sensitivity (p=0.041) and specificity (p=0.036), along with 95% confidence intervals to enhance interpretability (Table 1).

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Table 1: Diagnostic Performance Metrics of Doppler Ultrasound and MRI

Diagnostic Modality	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	True Positives (n)	True Negatives (n)	False Positives (n)	False Negatives (n)	p-Value	95% CI (Sensitivity, Specificity)
Doppler Ultrasound	86.5	89.1	88.2	87.5	64	68	8	10	0.041	(80.2–91.7, 83.7–93.2)
MRI	79.7	83.3	81.9	81.2	59	63	13	15	0.036	(72.3–85.4, 77.0–89.0)

Maternal outcomes showed significant differences between cases diagnosed via Doppler ultrasound and MRI. Doppler ultrasound was associated with a lower incidence of emergency hysterectomy (12 cases vs. 19 cases in the MRI group; p=0.032) and shorter ICU stays (mean of 3.5 days vs. 5.1 days; p=0.045). There was no significant difference in blood transfusion rates (p=0.283) (Table 2).

Table 2: Maternal Outcomes Based on Diagnostic Modality

Outcome	Doppler Ultrasound (n=64)	MRI (n=59)	p-Value
Emergency Hysterectomy	12	19	0.032
Average ICU Stay (Days)	3.5 ± 1.2	5.1 ± 1.6	0.045
Blood Transfusion (≥2 units)	24	26	0.283

Preterm births were more frequent in cases diagnosed with antepartum (p=0.028), with 38 cases in the Doppler ultrasound group and 42 in the MRI group. Similarly, low birth weight infants (<2,500 grams) were more common in the Doppler ultrasound group (p=0.037). NICU admission rates did not significantly differ between the two groups (p=0.451) (Table 3).

Table 3: Fetal Outcomes Based on Diagnostic Modality

Fetal Outcome	Doppler Ultrasound (n=64)	MRI (n=59)	p-Value
Preterm Birth (<37 Weeks)	38	42	0.028
Low Birth Weight (<2,500 g)	36	33	0.037
NICU Admission	29	27	0.451

DISCUSSION

In this study, we compared the diagnostic efficacy of Doppler ultrasound and MRI for the early detection of PA and its impact on maternal and fetal outcomes. Our findings highlight the superior sensitivity and specificity of Doppler ultrasound, underscoring its role as the primary diagnostic tool for PA. Beyond numerical comparisons, Doppler ultrasound offers advantages in terms of accessibility, cost-effectiveness, and ease of use in routine clinical settings, particularly in resource-limited environments. It also showed reduced maternal complications such as emergency hysterectomy and ICU stays. These results align with prior research that highlights the risk factors associated with diagnosing PA using imaging modalities and the importance of early detection to improve clinical outcomes [18]. The values of sensitivity and specificity found in our study for both modalities are slightly lower than those reported in earlier research. However, due to the risks associated with gadolinium in pregnancy, particularly nephrogenic systemic fibrosis, its use remains controversial. Our findings reinforce the importance of optimizing non-contrast MRI techniques to minimize fetal risks while maintaining diagnostic accuracy. The presence of low-signal-intensity intra-placental bands on MRI, a key marker of abnormal placentation, was detected in 78% of true-positive cases in our study, similar to findings from previous research [19, 20]. These bands likely represent areas of placental hemorrhage and infarction, as suggested by histologic examination [21, 22]. Quantifying the association between these MRI findings and histological outcomes could help refine diagnostic criteria in future studies. Despite the overall effectiveness of Doppler ultrasound, our study identified 10 false-negative cases and 8 false-positive cases with ultrasound, compared to 15 false-negative and 13 false-positive cases with MRI. The false-negative cases in both modalities were often attributed to posterior placentas or placentas interpreted as mature but later found to have abnormal placentation upon histologic examination. This highlights the need for tailored protocols for posterior placentas, potentially incorporating both modalities to improve diagnostic accuracy. Future research should focus on refining imaging protocols for Doppler ultrasound to minimize false-negative cases and on developing cost-effective strategies for integrating MRI in high-risk or complex cases. Studies examining the economic burden of PA diagnosis and management could guide resource allocation, especially in low- and middle-income countries. This approach allows for a more reliable comparison of diagnostic accuracy between the two modalities. However, our study has some limitations, which include a small sample size and potential bias due to the retrospective analysis. The sample was restricted to the patients who undertook both MRI and ultrasound, which may not fully reflect the broader population of high-risk pregnancies. Additionally, the prior knowledge of imaging results might have influenced subsequent interpretations. Further prospective, multicenter studies with relatively large sample sizes and people from different regions are suggested to validate our findings. Integrating subgroup analyses based on placental location, gestational age, and other confounding factors could provide deeper insights into diagnostic performance.

CONCLUSIONS

It was concluded that Doppler ultrasound is a better modality for early detection of PA as compared with MRI, having more sensitivity and specificity. It also

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demonstrated superior maternal and fetal outcomes, making it the preferred first-line diagnostic tool in most clinical scenarios. Given its accessibility and cost-effectiveness, Doppler ultrasound should be prioritized for routine screening of high-risk pregnancies. MRI, while less sensitive, remains a valuable adjunct, particularly in complex cases or when ultrasound findings are inconclusive. Prospective trials are also warranted to evaluate the long-term clinical implications of early PA detection on maternal and fetal health.

Authors Contribution

Conceptualization: ZEH
Methodology: ZEH, HN, MA, UA, SJ
Formal analysis: ZEH
Writing review and editing: RAA

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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