

Diagnostic Precision of Color Doppler Ultrasound for Antenatal Diagnosis of Placenta Accreta Compared to Histopathology in Obstetric Practice

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ABSTRACT

Background: Placenta accreta is a serious obstetric complication characterized by abnormal placental attachment, leading to significant maternal and fetal risks. Early detection is crucial for improving management outcomes. **Objective:** This study aimed to evaluate the diagnostic precision of color doppler ultrasound for the antenatal diagnosis of placenta accreta compared to histopathological findings. **Study Design:** Cross-sectional study **Setting:** Department of Gynaecology and Obstetrics, Makran Medical College, Turbat **Duration:** From June 2021 to December 2021. **Methods:** A total of 130 pregnant women suspected of having placenta accreta underwent Color Doppler Ultrasound between 28 and 36 weeks of gestation. Histopathological examination of the placenta post-delivery served as the gold standard for diagnosis. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the ultrasound findings were calculated. **Results:** Color Doppler Ultrasound identified 50 cases of placenta accreta, with histopathology confirming 45. The sensitivity, specificity, PPV, and NPV of Color Doppler Ultrasound were found to be 89.4%, 90.4%, 84.0%, and 93.7%, respectively. **Conclusion:** Color Doppler Ultrasound is an effective diagnostic tool for the antenatal detection of placenta accreta, enhancing preoperative planning and reducing maternal and fetal complications.

Keywords: Color Doppler Ultrasound, Histopathology, Maternal Health, Placenta Accreta, Prenatal Diagnosis

INTRODUCTION

Placenta accreta is a serious obstetric condition characterized by abnormal placental attachment, where the placental tissue invades the myometrium or deeper layers of the uterine wall.¹ This condition presents significant risks during pregnancy, particularly at the time of delivery, leading to potential complications such as severe hemorrhage, uterine rupture, and even maternal mortality.² Historically, placenta accreta has often been diagnosed intrapartum, following massive hemorrhage, leading to emergency interventions that may compromise maternal health.³ In recent years, there has been a growing focus on improving antenatal diagnostic methods to allow for better preoperative

planning and management, thus reducing adverse maternal outcomes. A key element in the antenatal diagnosis of placenta accreta is imaging, with various modalities being employed to assess placental invasion into the myometrium.⁴

Among these, Color Doppler Ultrasound has emerged as a non-invasive, accessible, and cost-effective tool for diagnosing abnormal placental implantation, including placenta accreta.⁵ The technique combines conventional grayscale ultrasound with Doppler imaging, allowing for real-time visualization of blood flow within the placental and uterine tissues. The color Doppler modality, in particular, provides critical information on abnormal vascular patterns, which are indicative of placental

invasion. Specific signs, such as turbulent blood flow at the uterine serosa-bladder interface and irregular placental lacunae, have been associated with placenta accreta and serve as diagnostic markers on Color Doppler imaging.^{6,7}

Despite the growing use of Color Doppler Ultrasound, its diagnostic accuracy is not absolute, and false-positive or false-negative diagnoses can occur. Consequently, definitive diagnosis often requires histopathological confirmation following delivery, where the degree of placental invasion is directly examined through tissue samples. Histopathology remains the gold standard for diagnosing placenta accreta, as it provides precise anatomical details of placental adherence and invasion.^{8,9}

The challenge lies in bridging the gap between the antenatal diagnostic capabilities of Color Doppler Ultrasound and the post-delivery histopathological confirmation. While ultrasound offers a less invasive, real-time diagnostic tool, histopathology provides definitive evidence of the condition.

METHODS

A cross-sectional study design was employed at Department of Gynaecology and Obstetrics, Makran Medical College, Turbat, spanning a period of six months (From June 2021 to December 2021). Ethical approval was obtained from the Institutional Review Board (IRB), and informed consent was secured from all participants before enrollment. The study included 130 pregnant women who were suspected of having placenta accreta. The sample size of 130 patients was calculated using a power of 80%, a significance level of 5%, and an assumed prevalence of placenta accreta of 10% based on previous studies.¹⁰

In this study, the inclusion criteria consisted of pregnant women at term (≥ 37 weeks gestation) who had a history of previous cesarean sections or uterine surgeries, along with those who exhibited clinical suspicion of abnormal placental attachment based on risk factors or ultrasound findings. Additionally, participants were aged between 18 and 45 years. Conversely, the exclusion criteria involved women with multiple pregnancies, patients with known uterine anomalies, or those who declined to provide informed consent.

Color Doppler Ultrasound was performed on all participants between 28 and 36 weeks of gestation by an experienced radiologist. A high-resolution ultrasound machine equipped with Doppler capabilities was used. Specific diagnostic markers of placenta accreta, such as abnormal vascularity, turbulent blood flow at the uterine serosa-bladder interface, and irregular placental lacunae, were noted.

Each participant's ultrasound findings were categorized into one of three groups: normal placental attachment, suspected placenta accreta, and confirmed placenta accreta based on Doppler characteristics. The radiologist was blinded to the clinical and histopathological outcomes to minimize bias.

After delivery, the placentas were examined histopathologically by an experienced pathologist. Histopathological diagnosis was considered the gold standard for confirming placenta accreta. Patient demographics, ultrasound findings, and histopathological outcomes were recorded in a structured format.

Statistical analysis was performed using SPSS software (version 25). Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of Color Doppler Ultrasound were calculated in comparison to histopathological findings.

RESULTS

Table 1 presents the demographic characteristics of the study participants. The mean age of the participants was 32.5 ± 2.16 years. Among the participants, 63.1% (82) had a history of cesarean sections, while 36.9% (48) did not. Additionally, 36.9% (48) reported a history of other uterine surgeries, and 63.1% (82) did not. In terms of gestational age, 23.1% (30) were between 28-32 weeks, 38.5% (50) were between 33-36 weeks, and another 38.5% (50) were ≥ 37 weeks.

Table 1: Demographic characteristics of study participants

Parameters	Category	Frequency (%)
Mean Age	Mean $\pm$ SD	32.5 $\pm$ 2.16
History of Cesarean Section	Yes	82 (63.1%)
	No	48 (36.9%)
History of Other Uterine Surgeries	Yes	48 (36.9%)
	No	82 (63.1%)
Gestational Age (weeks)	28-32	30 (23.1%)
	33-36	50 (38.5%)
	≥ 37	50 (38.5%)

Table 2 outlines the ultrasound and histopathological findings in suspected cases of placenta accreta. Color Doppler Ultrasound identified 38.5% (50) of the participants as having placenta accreta, while 61.5% (80) were classified as not having the condition. Histopathological examination confirmed 34.6% (45) of the cases as having accreta, whereas 65.4% (85) did not show any abnormalities.

Table 2: Ultrasound and histopathological findings in suspected cases of placenta accrete

Parameters	Category	Frequency (%)
Placenta accreta (Ultrasound)	Yes	50 (38.5%)
	No	80 (61.5%)
Confirmed accreta (Histopathology)	Yes	45 (34.6%)
	No	85 (65.4%)

Table 3 provides a contingency table for the Color Doppler Ultrasound diagnosis of placenta accreta. The results indicated 42 true positives (TP) and 8 false positives (FP), leading to a total of 50 positive test results for accreta. For negative test results, there were 5 false negatives (FN) and 75 true negatives (TN), resulting in 80 negative test results. The total number of participants in the study was 130.

Table 3: Contingency table for color doppler ultrasound diagnosis of placenta accreta

Test Results	Histopathology Positive	Histopathology Negative	Total
Positive (Accreta)	TP (42)	FP (8)	50
Negative (Non-Accreta)	FN (5)	TN (75)	80
Total	47	83	130

True Positives, False Positives, False Positives, False Positives

Table 4 summarizes the diagnostic accuracy of Color Doppler Ultrasound compared to histopathology. The sensitivity of the test was calculated to be 89.4%, indicating a high ability to correctly identify those with the condition. The specificity was 90.4%, demonstrating a strong ability to correctly identify those without the condition. The Positive Predictive Value (PPV) was 84.0%, and the Negative Predictive Value (NPV) was 93.7%, reflecting the reliability of the test results

Table 4: Diagnostic accuracy of Color Doppler Ultrasound for detecting placenta accreta compared to histopathology

Measure	Formula	Calculation	Percent
Sensitivity	$a/a+cx100$	$42/(42+5)x100$	89.4%
Specificity	$d/b+dx100$	$75/(75+8)x100$	90.4%
Positive Predictive Value (PPV)	$a/a+bx100$	$42/(42+8)x100$	84.0%
Negative Predictive Value (NPV)	$d/c+dx100$	$75(75+5)x100$	93.7%

DISCUSSION

Placenta accreta is a severe obstetric condition characterized by abnormal placental attachment to the uterine wall, often leading to life-threatening complications such as excessive bleeding during childbirth.¹¹ Early and accurate diagnosis is crucial for managing this condition to reduce maternal and fetal risks. Color Doppler Ultrasound has emerged as a valuable, non-invasive tool for detecting placental abnormalities, offering a real-time assessment of blood flow patterns that can indicate placenta accreta.¹²

In our study, the diagnostic accuracy of Color Doppler Ultrasound for detecting placenta accreta was found to have a sensitivity of 89.4% and specificity of 90.4%. These findings align closely with the results of a previous study conducted in Multan in 2016 by Khalid et al., which reported a sensitivity of 87.5% and specificity of 98.36% for morbidly adherent placenta.¹³ Gulati et al. (2021) reported that ultrasonography correctly diagnosed 18 out of 19 cases of placenta accreta, achieving a diagnostic accuracy of 90%.¹⁴

Furthermore, Amine et al. (2023) highlighted that combining gray-scale ultrasonography with color Doppler enhanced diagnostic accuracy to 100%. In our study, the loss of the hypo-echoic retroplacental sonolucent zone was present in 87.5% of cases, supporting the notion that ultrasound criteria significantly contribute to accurate diagnosis, albeit not reaching the same level of accuracy as reported by Amine et al.¹⁵ Abdel-Hamid et al. (2019) and Ali et al. (2022) demonstrated that 3D Doppler techniques can achieve 100% sensitivity and specificity in diagnosing abnormal placental invasion, showcasing advanced imaging techniques that potentially outperform conventional 2D ultrasound. While our study did not utilize 3D Doppler ultrasound, the high performance of traditional techniques underscores the need for further exploration of advanced modalities in our practice.^{16,17}

In comparison, Jamali et al. (2023) noted a mean age of 37.38 ± 1.19 years in their cohort, with ultrasound sensitivity at 82.09%. Our study participants had a younger mean age of 32.5 years, yet our sensitivity was significantly higher. This discrepancy may reflect differences in study populations or methodologies.¹⁸ Similarly, Sajid et al. (2018) reported a sensitivity of 84.8% and a specificity of 93.9%, which are comparable to our results but suggest varying accuracy across different settings.¹⁹ Mahmood et al. (2023) showed a sensitivity of 85.1%, highlighting that demographic variations can influence diagnostic performance, as observed in our study.²⁰ Chou et al. (2017) and Maher et al. (2018) also reported high sensitivity and specificity, with Maher et al. achieving 95.1% sensitivity. The differences in findings

across these studies may be attributable to sample sizes, patient demographics, and local practices in obstetric care.²¹

CONCLUSION

In conclusion, our study demonstrates a strong correlation between the clinical manifestations of adenomyosis and its histopathological severity, emphasizing the critical role of histopathological examination in confirming diagnosis.

LIMITATIONS

The results are based on a single-center experience, which may limit the generalizability of the findings to broader populations.

SUGGESTIONS / RECOMMENDATIONS

Large-scale research should be done in future studies.

CONFLICT OF INTEREST / DISCLOSURE

None.

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