

Diagnostic Accuracy of Doppler Ultrasonography in the Antenatal Diagnosis of Abnormal Placental Invasion Secondary to Placenta Previa Taking Operative Findings of Cesarean Section as Gold Standard; Experience of a Tertiary Care Hospital

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Abstract

Objective: To determine the diagnostic accuracy of Doppler ultrasonography in the antenatal diagnosis of abnormal placental invasion secondary to placenta previa in patients visiting Dr. Ziauddin Hospital, using operative findings of cesarean section as the gold standard.

Methodology: A cross-sectional prospective study was conducted in the Radiology department of Dr. Ziauddin Hospital from January 1, 2022, to June 30, 2022. A total of 271 pregnant multiparous women diagnosed with placenta previa on ultrasound were included. All patients underwent color Doppler ultrasound examination to assess the presence of abnormal placental invasion. The results of quantitative and qualitative variables, as well as abnormal placental invasions on color Doppler ultrasonography and operative findings, were recorded. Frequency and percentages were calculated for gravidity, abnormal placental invasions on colour Doppler USG and operative findings. Sensitivity, specificity, positive and negative predictive values and diagnostic accuracy of the color Doppler USG were calculated. Statistical analysis was performed using SPSS version 22.

Results: The average age of the patients was 26.61 ± 4.76 years. The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of Doppler ultrasonography in the antenatal diagnosis of abnormal placental invasion secondary to placenta previa were 85.1%, 93.8%, 74.1%, 96.8%, and 92.2%, respectively.

Conclusion: It is concluded that persistent placenta previa, particularly in patients with a history of prior cesarean section, should undergo antenatal transabdominal Doppler ultrasound to identify abnormal utero-placental vascular flow patterns.

Key Words: Placenta previa, Doppler Ultrasonography, Cesarean section.

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Introduction

Placenta previa is a potentially severe obstetric complication where the placenta lies within the lower segment of the uterus, causing an obstruction to the cervix and, consequently, to delivery. Placenta previa is a serious pregnancy complication and is the most common cause of postpartum hemorrhage, which often endangers the lives of pregnant women.¹ In recent years, an increasing number of researchers believe that the position of the placenta previa has a significant influence on pregnancy outcomes.²⁻³ Placenta accreta spectrum (PAS) is the latest term used to describe placenta accreta, increta, and percreta. The concept of

"PAS disorders," introduced by FIGO in 2018⁴, was initially defined by Luke et al.⁵ including abnormal adhesion and invasive placenta.

Women with placenta previa have a risk of developing placenta accreta, with an approximate rate of 3%.⁶ Due to the increase in the number of cesarean deliveries, the prevalence of placenta accreta spectrum has also risen. The risk of developing placenta accreta has been reported to increase with each cesarean section and is found to be 0.24% for the first, 0.31% for the second, 0.57% for the third, 2.13% for the fourth, 2.33% for the fifth, and 6.74% for the sixth or more cesarean deliveries, respectively.⁷ Other risk factors associated with placenta accreta spectrum include advanced

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maternal age, multiparity, previous uterine surgery, a female fetus, hypertensive disorders, and smoking.⁸⁻¹³ MRI is also the preferred modality for detecting placenta accreta spectrum and is usually performed in patients with suspicious findings on ultrasound for confirmation and better visualization of the extent of involvement in indeterminate or equivocal cases.

Several studies have evaluated the diagnostic accuracy of Doppler ultrasound and MRI of the pelvis in the detection of PAS. One study conducted by D'Antonio et al. suggested a sensitivity of 90.7% and specificity of 96.9% for ultrasound, and a sensitivity of 94.4% and specificity of 84% for MRI, respectively. Another study conducted by Meng et al. reported a sensitivity and specificity of 82% and 89%, respectively, for ultrasound, and a sensitivity and specificity of 82% and 88%, respectively, for MRI. Riteau et al. reported a sensitivity of 100% and a specificity of 37.5% for ultrasound, while MRI sensitivity was 76.9% with a specificity of 50%, respectively. Elhawari et al. reported that the sensitivity of ultrasonography was 82%, with a specificity of 89%.¹⁷ Maher et al. determined increased sensitivity and specificity of ultrasound compared to MRI, possibly due to the use of transvaginal ultrasonography.¹⁸ In high-risk patients with a history of multiple cesarean sections or previous pelvic surgery, MRI of the pelvis is also a valuable diagnostic modality for the antenatal diagnosis of placenta accreta in cases of low-lying placenta.

However, the major disadvantage and drawback of MRI is its cost, and it is not readily available in all healthcare facilities.¹⁹ In developing countries with a low socioeconomic profile, the use of MRI is challenging for the general population due to its cost and limited availability of facilities.²⁰ Therefore, the diagnosis typically relies on antenatal Doppler ultrasonographic findings, which have shown sensitivity ranging between 82.4% and 100%, and specificity between 92% and 96.8%.²¹ Considering Placenta accreta spectrum (PAS) as a life-threatening problem and aiming to establish a local perspective, this study will contribute to the development of management guidelines, addressing the current paucity of local data. The rationale of this study is to investigate the diagnostic accuracy of Doppler ultrasonography in identifying abnormal placental invasion, specifically in cases of placenta previa, to improve antenatal detection and patient outcomes.

Methodology

This cross-sectional prospective study was conducted in the Radiology department of Dr. Ziauddin Hospital from

January 1, 2021, to June 30, 2021, following approval from the institutional ethical review committee of the institute. The sample size was determined based on a sensitivity of 90.7%¹⁴, specificity of 84%¹⁵, and a placenta previa invasion prevalence of 12.2%(109). A margin of error (d) of 4% for sensitivity and 10% for specificity, with a confidence interval of 95%, led to a sample size of 271 patients. Non-probability consecutive sampling was employed, including all pregnant multiparous women aged 20-40 years with a diagnosis of placenta previa via ultrasound. Exclusion criteria encompassed patients who did not provide consent, primigravida, women with placenta previa but a history of prior normal vaginal deliveries, as well as complicated pregnancies such as pregnancy-induced hypertension, gestational diabetes, and cardiac disease. Informed consent was obtained from all patients, and a brief history was collected to gather demographic information.

All patients underwent color Doppler ultrasonography conducted by the radiology resident and women's imaging radiologist. Women with abnormal placental invasions identified through color Doppler ultrasonography were scheduled for elective cesarean delivery performed by an experienced senior gynecologist. The findings of quantitative variables (age and gestational age) and qualitative variables (gravidity, abnormal placental invasions on color Doppler ultrasonography, and operative findings) were recorded on a pre-designed form.

Statistical analysis was carried out using SPSS Version 22. For continuous variables such as age and gestational age, mean and standard deviations were calculated. Frequencies and percentages were computed for gravidity, abnormal placental invasions on color Doppler ultrasonography, and operative findings. Sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy of color Doppler ultrasonography were determined. Stratification was performed based on age, gravidity, and gestational age. Post-stratification analysis of diagnostic accuracy, positive and negative predictive values, sensitivity, and specificity were conducted.

Results

The average age of the patients was 26.61 ± 4.76 years, and the mean gestational age was 31.10 ± 2.39 weeks. Approximately 41% of women had more than three previous pregnancies. The prevalence of abnormal placental invasions, as indicated by operative findings, was found in 17.3% (47 out of 271) of patients. In 217

patients, no abnormal placental invasion was detected, as shown in Table I.

Table I: Diagnostic parameters of doppler ultrasonography and per-operative findings.

Doppler Ultrasound	Operative Findings		Total
	Positive	Negative	
Positive	40	14	54
Negative	7	210	217
Total	47	224	271

The results revealed a sensitivity of 85.1%, specificity of 93.8%, a positive predictive value of 74.1%, a negative predictive value of 96.8%, and an accuracy of 92.2% for Doppler ultrasonography in the antenatal diagnosis of abnormal placental invasion secondary to placenta previa (Figure 1).

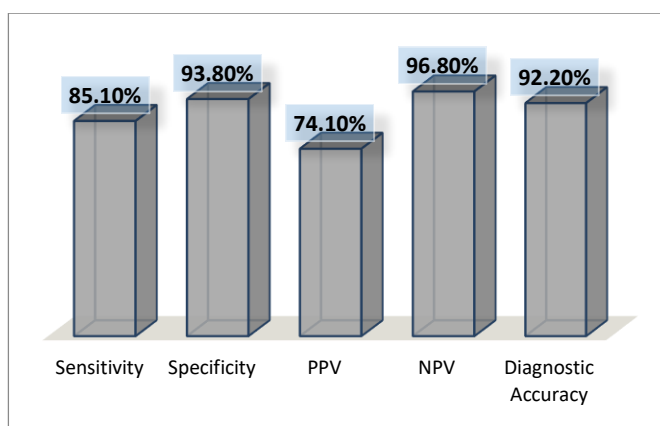


Figure 1. Stratification of diagnostic parameters in different groups.

Diagnostic accuracy of Doppler ultrasonography in the antenatal diagnosis of abnormal placental invasion secondary to placenta previa was also assessed based on age, gestational age, and gravidity, all of which were found to be at or above 90%, as reported in Table II.

Discussion

One of the serious and life-threatening obstetric complications associated with increased maternal morbidity and mortality is Placenta Accreta Spectrum (PAS), in which the placenta abnormally adheres, invading the myometrium or extrauterine structures. The

PAS includes three entities: accreta, increta, and percreta, representing increasing degrees of invasion from least to most severe. Placenta accreta involves the superficial myometrium, placenta increta extends deeper into the myometrium without involving the uterine serosa, and placenta percreta extends through the serosal surface into extrauterine structures.²²

In this study, the average age of the patients was 26.61 ± 4.76 years, with a mean gestational age of 31.10 ± 2.39 weeks. Of the patients, 32.47% resided in rural areas, and 67.53% resided in urban areas. In a study by Asghar and Naz²³, the age range was between 20 and 40 years with a mean age of 28.23 ± 4.31 years, and the mean gestational age was found to be 34.3 ± 1.82 weeks. In a study by Ayati et al.²⁴, the mean maternal age was 31.42 ± 4.2 years.

The prevalence of abnormal placental invasions in this study was 17.3%. The sensitivity was found to be 85.1%, specificity 93.8%, positive predictive value 74.1%, negative predictive value 96.8%, and accuracy 92.2% for the antenatal diagnosis of abnormal placental invasion secondary to placenta previa on Doppler sonography. Similar results were reported in a study, with sensitivity at 86.5%, specificity at 90.24%, positive predictive value (PPV) at 95.7%, and negative predictive value (NPV) at 72.5%.²⁴ In Sajid et al.'s study²³, the overall sensitivity was 84.8%, specificity 93.9%, and positive and negative predictive values were 91.8% and 88.5%, respectively.

A study conducted by Finberg and Williams stated a sensitivity of 93% and a specificity of 79% for color Doppler ultrasound.²⁵ Antenatal color Doppler examination has improved the diagnostic accuracy of conventional grayscale sonography.²⁶⁻²⁷ Lerner and colleagues also described a high sensitivity of 100% and a specificity of 94%, respectively. Similarly, Levine and colleagues reported a specificity and sensitivity of 92% and 86%, respectively.²⁸ The results of this study are consistent with the study conducted by Shih et al.²⁹

Table II: Stratified Diagnostic Accuracy in Placental Invasion.

Stratification	Sensitivity	Specificity	PPV	NPV	DA
Age					
<30 years	87.80%	92.80%	72%	97.30%	91.90%
>30 years	66.70%	100%	100%	93.80%	94.40%
Gestational age					
<30 weeks	94.10%	93.90%	80%	98.40%	93.90%
>30 weeks	80%	93.70%	70.60%	96.10%	91.40%
Gravidity					
<3	88.50%	93.30%	71.90%	97.70%	92.50%
>3	81%	94.40%	77.30%	95.50%	91.80%

Antenatal diagnosis of PAS, along with delivering these patients in hospitals equipped to handle operative and perioperative complications, will reduce maternal morbidity and mortality rates. Women with high-risk factors or a history of previous interventions should be clinically suspicious of placenta accrete and undergo appropriate evaluation with Doppler ultrasonography for confirmation. In challenging cases or when findings are equivocal, MRI of the pelvis may be used to confirm the extent of invasion.³⁰ The most standard and cost-effective imaging modality for diagnosing PAS is Doppler ultrasound. Levine et al., in their study, reported morbidly adherent placenta in seven out of 19 women at risk of the placenta accreta spectrum.²⁷ Chou et al.³¹ prospectively followed 80 women, with results showing a sensitivity of 82% and a specificity of 96.8%. Therefore, various studies have shown that Doppler ultrasound has increased sensitivity and specificity in diagnosing placenta accrete spectrum (PAS).³²

Maher et al. also suggested in their study that the accuracy of diagnosing placenta accreta can be further improved by using transvaginal ultrasonography, with increased sensitivity and specificity compared to MRI.¹⁸ Transvaginal sonography may enhance diagnostic accuracy by improving near-field resolution. Maher et al. stated that MRI added to the specificity of the diagnosis in cases where ultrasound interpretation was unclear. Another study by Lim et al. described that MRI had a higher sensitivity and specificity than Doppler sonography, with a sensitivity and specificity of 75% and 78%, respectively, while ultrasound had a sensitivity of 67% and specificity of 50%. They reported that placental hypointense bands in MRI increase specificity.³³ Riteau et al. also reported similar results when sonography and MRI were performed in all patients.³⁴

Various studies have examined the sensitivities of different imaging modalities in diagnosing placenta accrete spectrum. However, there is a slight shortage of available local data, which is why this study was conducted. The strength of our study is that it directly compared the accuracy of Doppler ultrasonography with operative findings. Furthermore, higher sensitivity and specificity have been shown in multiparous women during data stratification. This is a single-center study, which is a limitation, as the results cannot be generalized to the general population. More comprehensive multicenter studies involving a larger number of patients are required to generalize the findings and establish a standard protocol. A step-by-step, comprehensive diagnostic imaging approach is needed to increase

diagnostic accuracy and the radiologist's ability to diagnose PAS, ultimately facilitating and expediting treatment options and reducing maternal morbidity and mortality associated with it.

Conclusion

Placenta accreta spectrum refers to the abnormal extension of chorionic villi into the myometrium, leading to life-threatening, massive peripartum bleeding, endangering the patient's life. Therefore, antenatal diagnosis is crucial, for which Doppler ultrasonography (USG) plays a pivotal role. It is an easily accessible and cost-effective imaging modality compared to MRI, which is why it is more widely used for screening purposes. Any patient with risk factors should undergo antenatal transabdominal Doppler ultrasound to identify abnormal utero-placental invasion. The degree and severity of hemodynamic variations in uteroplacental circulation in placenta accreta must be considered during interpretation.

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