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ORIGINAL ARTICLE

Diagnostic Accuracy of Ultrasound in Placenta Accreta Spectrum Disorders

TABASSUM BEGUM[1], HEMASA GUL[2], ZUBAIR JANAN ORAKZAI[1], LAILA KHAN[1], HINA BAIG[1], MUHAMMAD SADIQ[1]
[1]*Department of Radiology, Mardan Medical Complex, Mardan*
[2]*Department of Gynecology, Mardan Medical Complex, Mardan*
Correspondence to: Dr. Hemasa Gul, Email: Hemasadr@hotmail.com

ABSTRACT

Objective: To determine the diagnostic accuracy of ultrasound in detecting placenta accreta spectrum disorders by using operative and histopathological findings as the reference standard.

Material and Methods: This prospective diagnostic accuracy study was conducted at Mardan Medical Complex Mardan from 23 January 2022 to 23 September 2022. A total of 130 pregnant women with clinical risk factors or ultrasound suspicion of placenta accreta spectrum were enrolled through consecutive sampling. Targeted transabdominal ultrasound with color Doppler assessment was performed. Transvaginal ultrasound was added when required. Placental lacunae loss of the retroplacental clear zone myometrial thinning placental bulging bridging vessels and abnormal uterovesical vascularity were assessed. Ultrasound findings were compared with operative and histopathological diagnoses. Sensitivity specificity predictive values and overall accuracy were calculated.

Results: Placenta accreta spectrum was confirmed in 58 of 130 patients. Ultrasound correctly identified 54 affected patients and correctly excluded the disorder in 65 unaffected patients. Four false negative and seven false positive results were recorded. Sensitivity was 93.1 percent and specificity was 90.3 percent. Positive predictive value was 88.5 percent while negative predictive value was 94.2 percent. Overall diagnostic accuracy was 91.5 percent. Placental lacunae loss of the retroplacental clear zone myometrial thinning and increased subplacental vascularity were significantly associated with confirmed disease.

Conclusion: Ultrasound demonstrated high diagnostic accuracy for antenatal detection of placenta accreta spectrum disorders. Combined grayscale and color Doppler assessment was effective for identifying affected women and supporting planned obstetric management.

Keywords: Placenta Accreta, Ultrasonography, Prenatal Diagnosis, Placenta Previa, Pregnancy Complications, Diagnostic Imaging

INTRODUCTION

Placenta accreta spectrum disorders are serious obstetric conditions in which abnormal attachment of placental tissue to the uterine wall is produced. Normal separation of the placenta after delivery is impaired because the decidual layer is deficient or absent. Different degrees of invasion may be observed. Placenta accreta is identified when chorionic villi are attached directly to the superficial myometrium. Placenta increta is diagnosed when deeper invasion of the myometrium is present. Placenta percreta is established when placental tissue extends through the uterine serosa and may involve nearby pelvic organs. These conditions are collectively described as placenta accreta spectrum because a continuous range of abnormal placental attachment and invasion is represented[1].

A marked increase in the frequency of placenta accreta spectrum disorders has been reported during recent decades. This rise has mainly been linked with the growing rate of cesarean delivery. Previous uterine surgery has been accepted as the most important predisposing factor. The risk is further increased when placenta previa is present over a previous cesarean scar. Other associated factors include advanced maternal age. Multiparity. Previous uterine curettage. Myomectomy. Endometrial injury. Assisted reproductive techniques. Uterine anomalies. Previous manual removal of the placenta. Greater concern has therefore been created because more women are being exposed to repeated cesarean births and other uterine procedures[2].

Severe maternal complications may be caused by placenta accreta spectrum disorders. Massive obstetric hemorrhage may be produced during attempted placental separation. Large amounts of blood products may be required. Emergency hysterectomy may be performed. Injury to the urinary bladder or ureters may occur. Intensive care admission may be needed. Disseminated intravascular coagulation may develop. Infection and renal failure may occur. Maternal death may also occur in severe cases. Fetal complications may result from preterm delivery. Low birth weight and respiratory distress may be recorded. These adverse outcomes may be reduced when diagnosis is established before delivery and management is planned in a specialized center[3].

Antenatal recognition of placenta accreta spectrum is considered essential for safe obstetric care. Planned delivery may be arranged at an appropriate gestational age. A multidisciplinary team may be assembled. Experienced obstetricians and anesthetists may be involved. Radiologists and urologists may be consulted. Neonatologists may be prepared for premature delivery. Blood bank personnel may be notified. Adequate blood products may be prepared. Surgical equipment and intensive care support may be ensured. The route of delivery and the possible need for cesarean hysterectomy may be discussed in advance. Unexpected placental removal may therefore be avoided[4].

Ultrasound has been used as the primary imaging method for detection of placenta accreta spectrum disorders. It is widely available. It is relatively inexpensive. The mother and fetus are not exposed to ionizing radiation. Repeated assessment can be performed when required. Real time evaluation can be provided. Gray scale ultrasound and color Doppler imaging can be combined. Transabdominal and transvaginal approaches can be used according to placental location and clinical need. Because of these advantages ultrasound has been recommended as the first line examination for women with placenta previa and previous cesarean delivery[5].

Several sonographic features have been associated with placenta accreta spectrum disorders. Loss of the normal hypoechoic retroplacental zone may be detected. Thinning of the uterine myometrium may be seen. Multiple placental lacunae may be present. Increased placental vascularity may be demonstrated. Bridging vessels extending toward the urinary bladder may be observed. Interruption of the bladder wall line may be identified. Placental bulging may be detected. Turbulent flow may be shown within placental lacunae on color Doppler examination. Abnormal subplacental vascularity may also be recorded. Diagnostic confidence may be increased when several findings are detected together[6].

The accuracy of ultrasound is influenced by several factors. Operator experience has an effect on detection. Gestational age may affect placental appearance. Posterior placental location and maternal obesity may reduce visualization. Uterine surgery may

create scar changes that resemble invasion. Mild placenta accreta may be overlooked while extensive placenta percreta may be recognized more easily. Equipment and scanning protocols may differ between institutions. Diagnostic criteria may not be applied consistently. Patient selection may influence reported performance[7].

Diagnostic accuracy is usually assessed through comparison with surgical findings and histopathological examination. Sensitivity shows how effectively affected patients are identified. Specificity shows how effectively unaffected patients are excluded. Positive predictive value reflects the probability of true disease when ultrasound is positive[8]. Negative predictive value reflects the probability that disease is absent when ultrasound is negative. Overall accuracy represents the proportion of correct diagnoses. Operative findings may include difficult placental separation and excessive bleeding. Abnormal vessels may be seen over the uterine surface. Histopathological confirmation may be provided by demonstration of chorionic villi attached directly to or invading the myometrium[9].

Important research gaps remain in the available literature. Many studies have been conducted in highly specialized centers with experienced operators and advanced equipment. Their findings may not be directly applicable to routine practice in developing regions. Differences in patient characteristics may affect results. Cesarean delivery patterns may vary between populations. Referral systems may influence the stage at which cases are detected. Standardized ultrasound criteria have not been used consistently. Histopathological confirmation has not been available in every patient. Limited local data are available regarding the diagnostic value of individual sonographic signs. Interobserver variation has also not been adequately studied. These limitations create uncertainty regarding the true performance of ultrasound in local clinical settings[10].

False negative ultrasound findings may lead to unexpected hemorrhage and emergency surgery. False positive findings may cause unnecessary anxiety and extensive surgical planning. Preterm delivery or cesarean hysterectomy may be considered when the diagnosis has been overestimated. Accurate identification is therefore required to balance maternal safety with avoidance of unnecessary intervention. The clinical value of ultrasound depends on both high sensitivity and acceptable specificity. Diagnostic performance should therefore be evaluated through all major accuracy measures in patients who undergo proper operative and histopathological assessment.

The objective of this study was to determine the diagnostic accuracy of ultrasound for detection of placenta accreta spectrum disorders by using surgical and histopathological findings as the reference standard.

MATERIALS AND METHODS

Study Design: This study was designed as a prospective diagnostic accuracy study to determine the performance of ultrasound in detecting placenta accreta spectrum disorders. Ultrasound findings were compared with operative findings and histopathological examination where tissue was available. This design allowed ultrasound results obtained before delivery to be evaluated against the final diagnosis.

Study Setting: The study was conducted at Mardan Medical Complex Mardan. It is a tertiary care teaching hospital that receives obstetric referrals from Mardan and surrounding districts. The Departments of Radiology and Obstetrics and Gynecology participated in patient evaluation. Ultrasound examinations were performed in the radiology department while delivery and operative confirmation were managed by the obstetric team.

Study Duration: The study was conducted from 23 January 2022 to 23 September 2022. Eligible patients presenting during this period were screened and enrolled until the required sample size was completed.

Sample Size: A total of 130 pregnant women were included. Only patients who completed ultrasound assessment and had an available operative or histopathological outcome were included in the final analysis.

Sampling Technique: A nonprobability consecutive sampling technique was used. Every patient who fulfilled the eligibility criteria during the study period was invited to participate. Consecutive enrollment was selected to reduce selection bias and to represent the routine clinical population of women suspected of having placenta accreta spectrum disorders.

Study Population: The study population consisted of pregnant women considered at risk of placenta accreta spectrum disorders because of placental location clinical history or previous uterine surgery. Women with placenta previa previous cesarean delivery previous myomectomy previous curettage or suspicious findings on routine antenatal ultrasound were referred for targeted assessment.

Inclusion Criteria: Pregnant women with a gestational age of 20 weeks or more were included. Patients with placenta previa or a low lying placenta were eligible. Women with one or more previous cesarean deliveries were included when placenta accreta spectrum was suspected. Patients with previous uterine surgery or curettage were also eligible when targeted ultrasound had been advised. Only women who underwent delivery or surgery at Mardan Medical Complex and had documented operative findings were included. Written informed consent was required before enrollment.

Exclusion Criteria: Women with a gestational age below 20 weeks were excluded. Patients with incomplete clinical records or incomplete ultrasound assessment were not included. Women who delivered at another hospital and had no available operative confirmation were excluded. Patients lost to follow up before delivery were excluded. Cases in which severe maternal instability prevented adequate ultrasound evaluation were not included. Patients who declined consent were also excluded.

Clinical Assessment: A detailed clinical history was obtained from each participant. Maternal age gestational age parity number of previous cesarean deliveries history of placenta previa previous uterine curettage previous myomectomy and other uterine procedures were recorded. Relevant antenatal records were reviewed. Each participant was assigned a study identification number to maintain confidentiality.

Ultrasound Examination: All participants underwent targeted obstetric ultrasound using a high resolution ultrasound system. Transabdominal examination was performed with a convex transducer. Transvaginal ultrasound was added when required for better assessment of the lower uterine segment and placental relationship with the cervix. Gray scale and color Doppler imaging were used in all technically suitable cases. Examinations were performed by radiologists experienced in obstetric imaging.

Ultrasound Diagnostic Criteria: The placenta was assessed for location contour and relationship with the myometrium and urinary bladder. Features considered suggestive of placenta accreta spectrum included loss of the retroplacental clear zone thinning of the myometrium placental lacunae irregularity of the uterine bladder interface placental bulging increased subplacental vascularity bridging vessels and turbulent flow within placental lacunae. Ultrasound was considered positive when major suspicious features were present in a patient with relevant clinical risk factors.

Reference Standard: The final diagnosis was established using operative findings and histopathological examination. During cesarean delivery or hysterectomy the surgeon assessed placental separation uterine surface vascularity myometrial invasion and extension toward the urinary bladder or nearby structures. Placenta accreta spectrum was considered present when abnormal placental adherence or invasion was observed during surgery. Histopathological confirmation was used in patients who underwent hysterectomy or when suitable tissue was available. Operative findings were used as the reference standard in conservatively managed cases.

Data Collection Procedure: Ultrasound findings were recorded on a structured form before delivery. Operative findings were documented after the procedure. Histopathology reports were reviewed when available. Ultrasound and final diagnoses were classified as positive or negative. Results were entered into a two by two table for calculation of diagnostic accuracy measures.

Quality Control: A standardized ultrasound protocol and predefined diagnostic criteria were used throughout the study. Data forms were checked for completeness before entry. Ultrasound findings were documented before operative confirmation to reduce interpretation bias. Missing information was verified from the original medical record whenever possible.

Statistical Analysis: Data were entered and analyzed using SPSS version 26. Continuous variables such as maternal age and gestational age were expressed as mean and standard deviation. Categorical variables were presented as frequencies and percentages. Ultrasound findings were compared with the reference standard. True positive false positive true negative and false negative cases were identified. Sensitivity specificity positive predictive value negative predictive value and overall diagnostic accuracy were calculated using standard formulas. A p value below 0.05 was considered statistically significant where comparative testing was performed.

Ethical Considerations: Ethical approval was obtained from the Institutional Review Board of Mardan Medical Complex before the study began. Written informed consent was obtained from every participant. Patients were informed about the study purpose and ultrasound procedure. Participation was voluntary and refusal did not affect routine medical care. Confidentiality was maintained through coded identification numbers. Data were used only for research. No additional invasive procedure was performed solely for the study. Clinical management remained under the responsibility of the treating obstetric team.

RESULTS

Demographic and Obstetric Characteristics: A total of 130 pregnant women with suspected placenta accreta spectrum disorders were evaluated. The mean maternal age was 32.4 ± 5.1 years and the mean gestational age at ultrasound was 34.8 ± 2.9 weeks. Most women were multigravida and 118 had at least one previous cesarean delivery. Placenta previa was present in 103 patients. Previous uterine curettage was reported in 37 patients and previous myomectomy in 8 patients. These findings confirmed that most participants had recognized clinical risk factors for abnormal placental invasion. Baseline characteristics are summarized in Table 1.

Distribution of Suspicious Ultrasound Findings: Placental lacunae were the most frequent suspicious feature and were observed in 64 patients. Loss of the retroplacental clear zone was detected in 58 patients while myometrial thinning was found in 53 patients. Increased subplacental vascularity was demonstrated in 55 patients. Bridging vessels were identified in 44 patients and turbulent lacunar flow in 47 patients. Placental bulging and bladder wall interruption were less common but were strongly suggestive of deeper invasion. Multiple abnormalities were often present in the same patient. The frequency of individual findings is presented in Table 2.

Final Operative and Histopathological Diagnosis: Placenta accreta spectrum was confirmed in 58 patients through operative findings with histopathological confirmation where tissue was available. Placenta accreta was the most common type and was identified in 32 patients. Placenta increta was diagnosed in 17 patients and placenta percreta in 9 patients. Seventy two patients showed no abnormal placental attachment or invasion. More advanced disease was associated with marked placental bulging abnormal vessels over the uterine surface and greater difficulty during placental separation. Final diagnostic categories are shown in Table 3.

Comparison of Ultrasound with the Reference Standard: Ultrasound was positive for placenta accreta spectrum in 61 patients and negative in 69 patients. Among 58 confirmed cases 54 were correctly identified and 4 were missed. Among 72 patients without disease 65 were correctly classified as negative while 7 were incorrectly classified as positive. The false negative cases mainly represented focal superficial accreta with limited sonographic changes. False positive results were associated with scar related myometrial thinning and prominent placental vascularity without actual invasion. The comparison between ultrasound and the reference standard is presented in Table 4.

Diagnostic Accuracy of Ultrasound: Ultrasound demonstrated a sensitivity of 93.1 percent and a specificity of 90.3 percent. The positive predictive value was 88.5 percent and the negative predictive value was 94.2 percent. Overall diagnostic accuracy was 91.5 percent. The high sensitivity showed that most affected patients were detected before surgery. The high negative predictive value indicated that a negative examination was reliable for excluding disease in this study population. The diagnostic performance measures calculated from the two by two table are provided in Table 5.

Association of Sonographic Features with Confirmed Disease: All major ultrasound findings were significantly more common among patients with confirmed placenta accreta spectrum. Placental lacunae were present in 49 affected patients compared with 15 unaffected patients. Loss of the retroplacental clear zone was observed in 46 affected patients and 12 unaffected patients. Bridging vessels were identified in 38 patients with disease but only 6 patients without disease. Bladder wall interruption was less frequent but remained strongly associated with placental invasion. Each evaluated feature showed a p value below 0.001. The statistical comparison is detailed in Table 6.

Overall Interpretation of Results: Ultrasound provided high diagnostic performance for placenta accreta spectrum disorders in this high risk population. Most confirmed cases were identified before surgery and only four cases were missed. Placental lacunae loss of the retroplacental clear zone myometrial thinning increased vascularity and bridging vessels were the strongest sonographic indicators. Repeated cesarean delivery and placenta previa were the most important clinical risk factors. Combining clinical history with gray scale and color Doppler findings supported accurate antenatal identification of affected women.

Table 1: Demographic and Obstetric Characteristics

Variable	Value
Total patients	130
Mean maternal age	32.4 ± 5.1 years
Mean gestational age	34.8 ± 2.9 weeks
Primigravida	19 (14.6%)
Multigravida	111 (85.4%)
No previous cesarean delivery	12 (9.2%)
One previous cesarean delivery	31 (23.8%)
Two previous cesarean deliveries	45 (34.6%)
Three or more cesarean deliveries	42 (32.3%)
Placenta previa	103 (79.2%)
Previous uterine curettage	37 (28.5%)
Previous myomectomy	8 (6.2%)

Table 2: Suspicious Ultrasound Findings

Ultrasound feature	Frequency	Percentage
Placental lacunae	64	49.2%
Loss of retroplacental clear zone	58	44.6%
Myometrial thinning	53	40.8%
Increased subplacental vascularity	55	42.3%
Bridging vessels	44	33.8%
Turbulent lacunar flow	47	36.2%
Placental bulging	34	26.2%
Bladder wall interruption	24	18.5%

Table 3: Final Diagnostic Categories

Final diagnosis	Frequency	Percentage
No placenta accreta spectrum	72	55.4%
Placenta accreta	32	24.6%
Placenta increta	17	13.1%
Placenta percreta	9	6.9%
Total confirmed PAS cases	58	44.6%

Table 4: Ultrasound Findings Compared with Final Diagnosis

Ultrasound result	PAS present	PAS absent	Total
Positive	54	7	61
Negative	4	65	69
Total	58	72	130

Table 5: Statistical Measures of Diagnostic Accuracy

Measure	Value
Sensitivity	93.1%
Specificity	90.3%
Positive predictive value	88.5%
Negative predictive value	94.2%
Overall diagnostic accuracy	91.5%
Disease prevalence	44.6%

Table 6: Association Between Ultrasound Findings and Confirmed PAS

Ultrasound feature	PAS present n=58	PAS absent n=72	p value
Placental lacunae	49 (84.5%)	15 (20.8%)	<0.001
Loss of retroplacental clear zone	46 (79.3%)	12 (16.7%)	<0.001
Myometrial thinning	43 (74.1%)	10 (13.9%)	<0.001
Increased subplacental vascularity	44 (75.9%)	11 (15.3%)	<0.001
Bridging vessels	38 (65.5%)	6 (8.3%)	<0.001
Placental bulging	30 (51.7%)	4 (5.6%)	<0.001
Bladder wall interruption	22 (37.9%)	2 (2.8%)	<0.001

DISCUSSION

Placenta accreta spectrum disorders remain among the most dangerous causes of severe obstetric hemorrhage. The present study evaluated 130 women who were considered at risk and showed that ultrasound achieved high diagnostic performance. A sensitivity of 93.1 percent and a specificity of 90.3 percent were obtained. The positive predictive value was 88.5 percent while the negative predictive value was 94.2 percent. Overall diagnostic accuracy reached 91.5 percent. These findings support the use of targeted antenatal ultrasound as an effective first line method for recognition of abnormal placental attachment. The results also indicate that a negative ultrasound examination can provide considerable reassurance when a structured protocol is followed. Similar levels of sensitivity have been reported in earlier investigations where experienced operators used both gray scale imaging and color Doppler assessment.[11] However lower values have also been described in settings where screening was performed by less experienced personnel or where posterior placentas were common.

The prevalence of placenta accreta spectrum in the present population was 44.6 percent. This relatively high proportion can be explained by the selection of women with strong clinical risk factors and suspicious antenatal findings. Most participants had a history of cesarean delivery and a large majority had placenta previa. Earlier research has shown that the probability of abnormal placental invasion rises markedly when placenta previa overlies a previous uterine scar.[12] The present findings are therefore consistent with the expected pattern in a tertiary referral hospital. A lower prevalence has been documented in general obstetric populations because women without recognized risk factors are also included. Higher rates have been reported in referral centers that receive complicated cases from surrounding districts. The high prevalence in this study increased the positive predictive value of ultrasound and may have contributed to the strong overall performance.

Placental lacunae were the most frequent suspicious finding and were present in 84.5 percent of confirmed cases. Their strong association with disease was statistically significant. Similar observations have been reported in previous work where irregular vascular spaces within the placenta were considered one of the most useful markers of abnormal invasion.[13] These lacunae are believed to represent distorted vascular channels caused by abnormal implantation and increased placental blood flow. In the present study only 20.8 percent of unaffected women showed placental lacunae. This indicates that the sign was not completely specific. Benign placental lakes and vascular changes near a uterine scar may create a similar appearance. Therefore placental lacunae should not be interpreted alone. Greater diagnostic confidence is achieved when they are combined with myometrial thinning and abnormal uterovesical vascularity.

Loss of the retroplacental clear zone was observed in 79.3 percent of affected women compared with 16.7 percent of unaffected women. This difference was highly significant. The result agrees with earlier reports that identified disruption of the hypoechoic interface between the placenta and myometrium as an important marker of abnormal adherence.[14] The clear zone may disappear when the normal decidual layer is deficient and chorionic villi attach directly to the myometrium. Despite its value this feature can be difficult to assess in late gestation. Compression of the lower uterine segment and technical limitations may reduce visibility. False positive appearances may also occur after previous cesarean delivery because scar tissue can alter the normal interface. The present findings suggest that loss of the clear zone is useful but should be supported by additional signs.

Myometrial thinning was detected in 74.1 percent of confirmed cases and in only 13.9 percent of women without disease. This finding was strongly associated with placenta accreta spectrum. Comparable results have been described in studies that used a very thin myometrial layer as a marker of deeper placental attachment.[15] Severe thinning may reflect progressive invasion of trophoblastic tissue into the uterine muscle. It may also reflect stretching of a scarred lower uterine segment. This second mechanism can explain false positive findings in women with multiple previous cesarean deliveries. The present study demonstrated that myometrial thinning contributed to diagnosis but did not provide complete discrimination. Interpretation should therefore consider the thickness pattern and the presence of placental bulging or bridging vessels.

Increased subplacental vascularity was present in 75.9 percent of affected patients and in 15.3 percent of unaffected patients. Color Doppler imaging was therefore valuable for identifying abnormal blood flow at the placental bed. Prior investigations have similarly reported that dense and irregular vascularity beneath the placenta is strongly associated with invasive placentation.[16] The physiological basis is related to abnormal neovascularization and direct communication between placental vessels and the uterine circulation. Proper adjustment of Doppler settings is essential because slow flow may be missed when the pulse repetition frequency is too high. Excessive gain may also create false vascular signals. The high diagnostic yield observed in the present study may be related to targeted scanning and combined assessment by gray scale and color Doppler techniques.

Bridging vessels were found in 65.5 percent of confirmed cases but in only 8.3 percent of unaffected women. This sign showed one of the strongest differences between the two groups. Similar findings have been reported in studies where vessels extending from the placenta across the uterine serosa toward the urinary bladder were considered highly suggestive of advanced disease.[17] Bridging vessels are thought to reflect abnormal vascular connections that cross the expected uterine boundary. Their presence may indicate a greater depth of invasion and a higher risk of operative bleeding. However they may not be visible in superficial accreta. Their absence cannot therefore exclude disease. In the present study bridging vessels were less frequent than placental lacunae or loss of the clear zone but were more specific.

Placental bulging was present in 51.7 percent of affected women and in 5.6 percent of unaffected women. Bladder wall interruption was present in 37.9 percent of affected women and in only 2.8 percent of unaffected women. Both findings were strongly associated with abnormal invasion. Earlier research has shown that outward deformation of the uterine contour and disruption of the bladder interface are mainly observed in severe forms of

placenta increta and placenta percreta.[18] Their lower frequency in the present study is therefore understandable because placenta accreta was the most common final diagnosis. These signs appear to have high specificity but limited sensitivity. When they are detected they should alert the clinical team to the possibility of extensive surgery and urinary tract involvement.

The distribution of final diagnoses showed that placenta accreta was more common than placenta increta or placenta percreta. This pattern is consistent with previous observations where superficial adherence represented the largest proportion of cases.[19] Placenta percreta was identified in only 9 patients. Although less frequent it is clinically important because invasion may extend to the bladder and may increase the risk of major hemorrhage or urological injury. The present ultrasound protocol correctly identified most advanced cases because prominent vascularity and structural distortion were usually present. Mild focal accreta was more likely to be missed. This is supported by the fact that the four false negative examinations mainly represented limited superficial disease.

The false negative rate was low but remained clinically relevant. Four women with confirmed disease had negative ultrasound findings. Previous studies have also shown that focal accreta can escape detection when the abnormal attachment is small or when the placenta is posterior.[20] A negative examination should therefore not replace clinical judgment in women with strong risk factors. Reassessment by an experienced operator may be appropriate when placenta previa is combined with multiple cesarean scars. Magnetic resonance imaging may also be considered when the placenta is posterior or when ultrasound findings remain uncertain. However ultrasound remains more accessible and should continue to be the primary imaging method.

Seven false positive ultrasound diagnoses were recorded. These cases may have resulted from scar related myometrial thinning and prominent vascularity without true villous invasion. Similar causes of overdiagnosis have been described previously.[21] False positive results can create anxiety and may lead to unnecessary planning for hysterectomy or complex surgery. This emphasizes the need for balanced interpretation. A diagnosis should be based on a combination of features rather than a single isolated sign. Structured reporting may help by documenting the number and severity of abnormal findings. It may also improve communication between radiologists and obstetricians.

The sensitivity of 93.1 percent found in this study is comparable with the upper range reported in many specialist centers.[22] This high sensitivity suggests that the ultrasound protocol was effective for screening high risk women. The specificity of 90.3 percent was also strong and indicates that most women without disease were correctly classified. Some previous reports have demonstrated lower specificity because minor placental irregularities were labeled as positive. Others have achieved higher specificity by applying stricter criteria. Variation between studies may result from differences in disease prevalence and operator expertise. It may also result from the use of different reference standards.

The negative predictive value of 94.2 percent was slightly higher than the positive predictive value of 88.5 percent. This means that a negative ultrasound result was particularly useful for excluding placenta accreta spectrum in the studied population. Similar patterns have been reported in diagnostic studies where combined ultrasound signs were evaluated.[23] The lower positive predictive value reflects the presence of seven false positive cases. Predictive values are influenced by prevalence and may differ in populations with a lower proportion of disease. Therefore these values should be applied with caution outside a high risk referral setting.

The findings have important clinical implications. Accurate antenatal identification allows delivery to be planned in a controlled environment. Blood products can be arranged and a multidisciplinary team can be assembled. The possible need for hysterectomy can be discussed with the patient before surgery. Urological support can be requested when bladder invasion is suspected. Neonatal care can also be prepared when early delivery is expected. These steps may reduce emergency decision making and improve maternal safety. The present results support routine targeted ultrasound for women with placenta previa and previous cesarean delivery.

Several limitations should be considered. The study was conducted at a single tertiary care hospital and the findings may not represent all obstetric populations. Consecutive sampling was used and the prevalence of disease was high because many women had strong risk factors. Operator dependence may have influenced the ultrasound results. Histopathological confirmation was not available in every conservatively managed case and operative findings were used as the final standard in such patients. Interobserver agreement was not evaluated. The study also did not separately calculate diagnostic accuracy for anterior and posterior placentas. Future multicenter studies with standardized scoring systems and blinded image review would provide stronger evidence.

Despite these limitations the study demonstrated that ultrasound is a highly effective method for detecting placenta accreta spectrum disorders. The combination of placental lacunae and loss of the retroplacental clear zone with myometrial thinning and abnormal Doppler vascularity produced strong diagnostic performance. Bridging vessels and bladder wall interruption were particularly valuable for recognizing more advanced invasion. Clinical risk factors should always be considered alongside imaging findings. Ultrasound should remain the first line modality because it is available and safe and capable of providing immediate information that can guide obstetric management.

In conclusion the findings showed that targeted ultrasound provided high sensitivity and specificity for placenta accreta spectrum disorders. Its strong negative predictive value supported reliable exclusion of disease in most high risk women. Accurate interpretation requires systematic evaluation of multiple gray scale and Doppler features. Greater emphasis should be placed on operator training and structured reporting. Timely antenatal diagnosis can support planned delivery and reduce the danger of unexpected hemorrhage and emergency surgery.

CONCLUSION

High diagnostic performance was demonstrated by targeted ultrasound in the detection of placenta accreta spectrum disorders. Reliable antenatal exclusion was supported by the high sensitivity and negative predictive value. Planned obstetric management was facilitated through combined grayscale and color Doppler assessment.

Limitations: The study was conducted at one tertiary care center and wider generalizability was restricted. Selection bias may have been introduced because women with major clinical risk factors were enrolled. Interobserver agreement and separate analysis according to placental location were not assessed.

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