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Role of Transabdominal Color Doppler Ultrasound in the Evaluation for Antenatal Diagnosis of Placenta Accreta Spectrum Disorder in Women with Placenta Previa

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Abstract

Background: Placenta accreta is a severe pregnancy complication causing postpartum hemorrhage, bladder injury, and peripartum hysterectomy. Ultrasonography for antenatal diagnosis of PAS disorder has shown reduced maternal morbidity and death, making it crucial for management. This study determined the diagnostic value of ultrasound for the antenatal diagnosis of placenta accreta spectrum in women with placenta previa. ***Methods:*** This prospective observational study was conducted in the Department of Obstetrics and Gynaecology of Dhaka Medical College from June 2022 to May 2023. Forty pregnant women with placenta previa attending the outpatient section were included. Patients underwent ultrasound to assess the placenta and diagnose placenta accreta spectrum. Patients were followed until delivery. Pregnancy outcomes and perioperative diagnoses were observed or obtained from hospital records. ***Results:*** The mean age was 30.58 ± 3.82 years, with the majority of participants aged 30–40 years. About 52.5% had parity ≥3, 60% had cesarean section ≥2, and 20% had previous placenta previa. A significant link existed between parity (≥3), cesarean history (≥2), age (≥32 years), and preoperative PAS diagnosis. Ultrasonography showed that 72.5% had a placenta accreta spectrum, while intraoperative findings showed 80%. Among PAS cases, placenta increta (40.6%) and percreta (40.6%) were most common, followed by accreta (18.8%). In management, 87.5% underwent peripartum hysterectomy, and 21.5% had bladder injury repair. Based on perioperative identification, USG showed 84.38% sensitivity, 75.00% specificity, and 82.50% accuracy. ***Conclusion:*** Eighty percent of participants had placenta accreta syndrome. PAS was linked with age over thirty-two, higher parity, and multiple cesarean sections. Most needed peripartum hysterectomy, and one-fifth required bladder repair. Antenatal ultrasonography is a feasible diagnostic tool with sufficient accuracy that may reduce peripartum complications.

Keywords: Placenta Accreta Spectrum (PAS), Ultrasonography, Placenta Previa, Peripartum Hysterectomy.

INTRODUCTION

Massive obstetric hemorrhage is still the leading cause of pregnancy-related deaths, and placenta previa accreta is one of the major predisposing factors [1]. The placenta accreta is an unusually strong attachment of placental villi to the uterine wall that lacks the fibrinoid layer of Nitabuch and the normal intervening decidua basalis [2]. The incidence has dramatically increased in the last 20 years, and it is highest among women with placenta previa who have a previous cesarean section. A national case-control study using the UK Obstetric Surveillance System found that the incidence of PAS increases from 1.7 per 10000 births overall to 577 per 10000 births in women with both a previous caesarean delivery and placenta previa [3]. The major contributing factor to this is believed to be the increase in the rate of cesarean delivery and subsequently placenta previa [4]. The condition poses a dramatic risk for massive hemorrhage and associated complications such as consumptive coagulation, multisystem organ

failure, and death. Placenta accreta patients are more likely to experience surgical problems, such as damage to the bladder, ureters, bowel, or the need for reoperation. Early diagnosis before delivery enables better planning of the timing, location, and surgical approach, which helps reduce blood loss and associated risks [4]. Ultrasonography is a valuable tool for antenatal detection of placenta accreta, primarily when performed by experienced professionals. Managing delivery in specialized centers with multidisciplinary teams has been shown to improve outcomes and lower maternal complications.

Women who have previously had a cesarean delivery and present with placenta previa are now the largest group at the highest risk for placenta accreta. In women with placenta previa, older maternal age (35 years) and a history of previous cesarean delivery were independent risk factors for placenta accreta [5]. Prenatal diagnosis of invasive placentation is associated with a reduced risk of maternal complications such as peripartum blood loss, need for massive transfusions, and hysterectomy rate, as it allows a pre-planned treatment of the condition. However, up to two-thirds of PAS cases remain undiagnosed prenatally [6].

Ultrasound is usually considered the first-line tool in the diagnostic pathway of abnormal placentation. Recently, the diagnostic performance of ultrasound has been generally reported to be good, with sensitivity ranging from 77% to 97% and specificity of up to 97% [7]. Ultrasonographic findings include loss of the standard retroplacental hypocchoic zone, thinning or disruption of the hyperechoic interface between the uterine serosa and the bladder, intra-placental vascular lacunae, and loss of the regular venous flow pattern of the peripheral placental margin have led to accurate diagnoses of placenta accreta in 78% to 100% of cases [8].

Several previous studies have demonstrated differences in the antenatal detection rates of PAS in women with placenta previa. Between-study differences can be attributed to a limited sample size, retrospective design, variability in study inclusion criteria, and confirmation of PAS diagnosis at delivery and/or by histopathology [3]. Since the presence of histopathological features of PAS without complications, such as bleeding, is of limited clinical significance, we planned a prospective study to evaluate the diagnostic performance of third-trimester ultrasound for the diagnosis of clinically significant PAS.

Accurate prenatal diagnosis is fundamental to reduce the burden of maternal morbidities associated with this risk, such as massive hemorrhage, damage to adjacent organs, and admission to the intensive care unit, by allowing a pre-planned management in centers with a high level of expertise in surgical treatment [9].

The majority of research indicated that ultrasound is highly accurate in identifying invasive placentation diseases in high-risk pregnant women. Despite these, the accuracy of prospective sonographic prenatal detection of invasive placentation remains unclear. This study aims to assess the diagnostic accuracy of color Doppler ultrasound in detecting the placenta accreta spectrum in women with placenta previa.

OBJECTIVE

The objective of this study was to determine the diagnostic value of color Doppler ultrasound for antenatal diagnosis of placenta accreta spectrum in women with placenta previa.

METHODOLOGY & MATERIALS

This prospective observational study was conducted at the Department of Obstetrics & Gynaecology, Dhaka Medical College and Hospital, Dhaka, Bangladesh, from June 2022 to May 2023. The study included 40 pregnant women diagnosed with low-lying placenta or placenta previa who visited the outpatient department during the study period.

Inclusion Criteria:

I. Women aged between 18 and 40 years
II. Ultrasonographically diagnosed placenta previa
III. Gestational age ≥ 26+0/7 weeks at the time of ultrasound examination
IV. Willingness to participate with informed consent

Exclusion Criteria:

I. Refusal to provide informed consent
II. Normally located placenta
III. Intrauterine fetal death

Data Collection and Study Procedure:

After obtaining approval from the institutional ethics committee and written informed consent from each participant, data collection was initiated using a pre-tested, structured questionnaire. Baseline maternal characteristics, obstetric and medical history were recorded. Each participant underwent a transabdominal ultrasound examination with a moderately full bladder to evaluate placental position and uterine-bladder interface.

A follow-up ultrasound was conducted between 34 and 36 weeks of gestation to reassess placental location. Color Doppler ultrasound was utilized to identify signs suggestive of placenta accreta spectrum (PAS), including:

1. Uterovesical hypervascularity – prominent vascular signals between the myometrium and bladder wall
2. Subplacental hypervascularity – increased vascularity at the placental bed

3. Bridging vessels – vessels traversing the myometrium and extending beyond the serosa
4. Placental lacunae feeder vessels – high-velocity flow into placental lacunae
5. 3D intraplacental hypervascularity – irregular and tortuous vascular architecture within the placenta

Fetal heart rate monitoring was performed using cardiotocography (CTG). Participants were monitored throughout the antenatal period, and pregnancy outcomes, including the need for peripartum hysterectomy, bladder injury, number of blood transfusions, hospital stay duration, and clinical diagnosis of placental abruption syndrome (PAS), were recorded from hospital records.

Clinical diagnosis of PAS at cesarean section was categorized into:
Grade 1 (Placenta Adherenta): No separation with oxytocin and traction, heavy bleeding upon manual removal, no gross placental invasion
Grade 2 (Placenta Increta): Placental bulge, neovascularity, dimple sign, no external placental invasion
Grade 3 (Placenta Percreta): Visible placental tissue invading uterine serosa or bladder, no identifiable surgical plane between uterus and bladder

Ethical Considerations:

Prior to the commencement of the study, ethical clearance was obtained from the Ethical Review Committee of Dhaka Medical College. All participants were informed about the purpose, procedures, potential risks and benefits, and alternative diagnostic options related to the study clearly and understandably, using the local language. Written informed consent was obtained from each participant before enrollment. Confidentiality and anonymity were strictly maintained throughout the study. Each participant was assigned a unique identification number, and all data were coded and securely stored in a locked cabinet accessible only to authorized research personnel. There were no physical, psychological, social, or legal risks to the participants during the study procedures. All ethical principles outlined in the Declaration of Helsinki were adhered to during the conduct of this research.

Statistical Analysis:

Data were analyzed using SPSS version 23. Collected data were checked for completeness, accuracy, and consistency. Continuous variables were presented as mean± standard deviation or median (range), and categorical variables as frequency (percentage). Associations between categorical variables were tested using the Chi-square test or Fisher's exact test, where appropriate. The diagnostic accuracy of color Doppler ultrasound for antenatal PAS diagnosis was evaluated in terms of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy. A p-value < 0.05 was considered statistically significant.

RESULTS

Table 1: Sociodemographic characteristics of the participants (n=40)

Demographic characteristics		Frequency (n)	Percentage (%)
Age (years)	18-<30	18	45.0
	30-40	22	55.0
	Mean±SD	30.58±3.82	
Occupation	Housewife	35	87.5
	Daily laborer	1	2.5
	Government employee	1	2.5
	Self employed	3	7.5
Socio-economic status	Lower class	17	42.5
	Middle class	22	55.0
	Higher class	1	2.5
Educational status	Illiterate	3	7.5
	Read and write only	11	27.5
	Primary	9	22.5
	Secondary	10	25.0
	Higher secondary	1	2.5
	University graduate	6	15.0

The mean age of the participants with placenta previa who attended the study was 30.5843 ± 8.2, and the median (range) was 30 (22-37). The majority (55.0%) of the participants were from the 30-40 years age group. Almost 90% of them were housewife. More than half of the participants came from the middle-class society. Only 7.5% of the participants were illiterate, and about 27.5% of the participants could read and write only.

Table 2: Distribution of the participants according to their gynaecological and obstetrics characteristics (n=40)

Gynaecological and obstetrical history		Frequency (N)	Percentage (%)
Gravidity	≥4	16	40.0
	<4	24	60.0
	Mean±SD	3.6±1.05	
Parity	≥3	21	52.5
	<3	19	47.5
	Mean±SD	2.53±1.06	
History of menstrual regulation	Yes	3	7.5
	No	37	92.5
History of abortion	Yes	13	32.5
	No	27	67.5
History of previous placenta previa	Yes	8	20.0
	No	32	80.0
History of cesarean section	≥2	24	60.0
	<2	16	40.0
	Mean±SD	1.63±0.61	
Weeks of gestation	Mean±SD	35.13±0.88	
	Median (range)	35 (33-36)	

The mean gravidity of the participants was 3.64 ± 1.05, and the mean parity was 2.53 ± 1.06. About 52.5% of the participants were of parity 23. About 7.5% of the participants had a history of MR, and almost one-third of the participants had a history of abortion. One-fifth had a history of previous placenta previa. And 60% of the participants had a history of 22 cesarean sections. The mean weeks of gestation was 35.13 ±0.88.

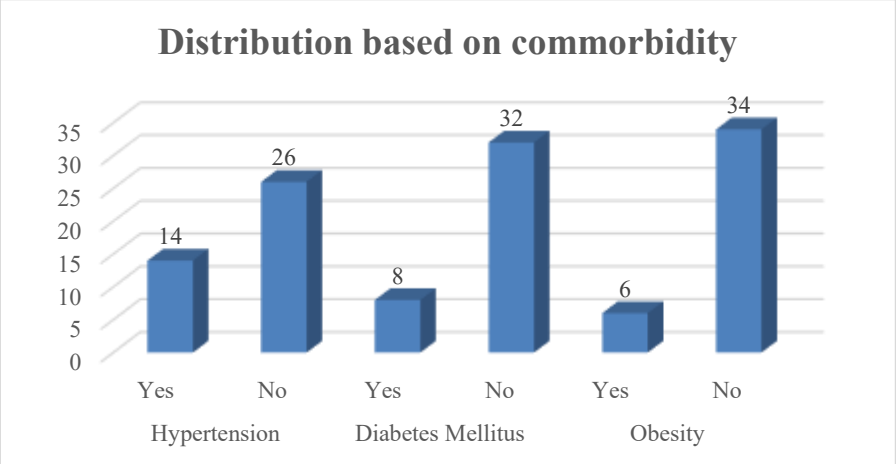

Figure 1: Distribution of the participants according to their comorbidity (n=40)

Among the participants, 35% (n=14) had hypertension, 20% (n=8) had diabetes mellitus, and 15% (n=6) had obesity.

Table 3: Distribution of the participants based on their clinical characteristics (n=40)

Physical and clinical parameters		Value
Systolic blood pressure (mm Hg)	Mean±SD	113.87±11.57
	Median (range)	110 (100-140)
Diastolic blood pressure (mm Hg)	Mean±SD	74.2±7.78
	Median (range)	70 (60-90)
Pulse/minutes	Mean±SD	88.47±9.38
	Median (range)	92 (68-110)
BMI (kg/m2)	Mean±SD	28.03±2.69
	Median (range)	28.4 (22.77-33.30)
Anemia	Present	32 (80.0%)
	Absent	8 (20.0%)
Jaundice	Present	0 (0.0)
	Absent	40 (100.0%)

Mean systolic blood pressure was 113.87 plus/minus 11.57 mm of Hg. The mean ± SD of diastolic blood pressure was 74.2 plus/minus 7.781 mm of Hg. About one-fourth of the participants were anemic, whereas no one was found to be jaundiced.

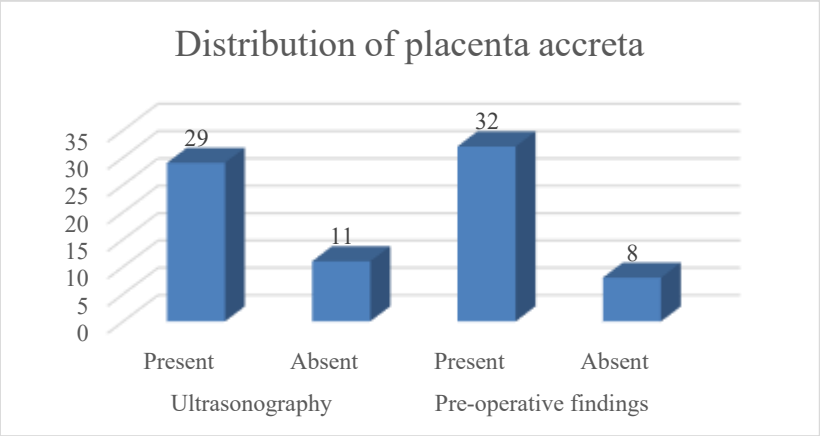

Figure 2: Distribution of placenta accreta spectrum according to ultrasonography and pre-operative findings (n=40)

On ultrasonography, a placenta accreta spectrum was diagnosed in 72.5% (n=29) of cases; whereas, on per-operative findings, it was revealed that 80% (n=32) of the participants with placenta previa were suffering from a placenta accreta spectrum.

Table 4: Association of placenta accreta spectrum (pre-operative findings) with parity

Parity	Placenta accreta spectrum		Total	P-value
	Present	Absent		
≥3	20 (95.2%)	1 (4.8%)	21	0.017
<3	12 (63.2%)	7 (36.8%)	19	
Total	32 (80.0%)	8 (20.0%)	40	

Among the patients with parity 23, about 20 (95.2%) were suffering from placenta accreta spectrum. On the other hand, only 12 (63.2%) of the participants with parity <3 was suffering from placenta accreta spectrum. Proportionately, patients with placenta previa and parity 3 were suffering significantly more than those with parity <3 (p value: 0.017).

Table 5: Association of placenta accreta spectrum (pre-operative findings) with history of cesarean section

History of Cesarean section	Placenta accreta spectrum		Total	P-value
	Present	Absent		
≥2	22 (91.7%)	2 (8.3%)	24	0.042
<2	10 (62.5%)	6 (37.5%)	16	
Total	32 (80.0%)	8 (20.0%)	40	

Among the patients with a history of CS 22, about 22 (91.7%) were suffering from placenta accreta spectrum. On the other hand, only 10 (62.5%) of the participants with a history of CS 2 were suffering from placenta accreta spectrum. Proportionately, patients of placenta previa with a history of CS 22 were suffering significantly more than those with a history of CS <2 (p value: 0.042).

Table 6: Distribution of management of PAS patient

Management		Frequency (n)	Percentage (%)
Mode of delivery	Elective cesarean section	6	15
	Emergency cesarean section	34	85
Needed peripartum hysterectomy	Yes	28	70
	No	4	10
Bladder injury and repairment	Yes	7	17.5
	No	25	62.5
Unit of blood transfusion	Mean±SD	3.03±0.82	
	Median (range)	3 (2-4)	

Hospital duration	Mean±SD	4.87±1.66
	Median (range)	4.5 (2-7)

Among the participants suffering from placenta accreta spectrum, 28 (87.5%) required to undergo hysterectomy. The mean unit of blood needed for managing patients was 3.03 (0.82), and the median (range) was 3 (2-4). The mean hospital duration was 4.87 1.66 days. The majority of the patients underwent emergency cesarean section.

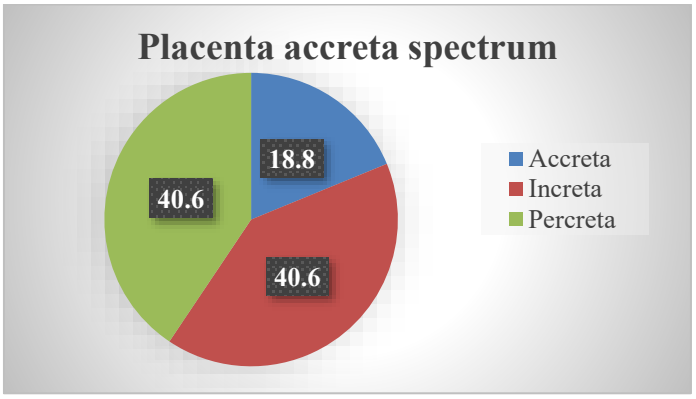

Figure 3: Distribution of placenta accreta spectrum among participants (pre-operatively) (n=32)

Among the participants suffering from placenta accreta spectrum, the majority had placenta increta (40.6%), followed by percreta (40.6%), and then accreta (18.8%).

Table 7: Cross tabulation of PAS according to ultrasonography and pre-operative findings

USG findings of PAS	Preoperative findings of PAS		Total
	Present	Absent	
Present	27	2	29
Absent	5	6	11
Total	**32**	**8**	**40**

It appears from table VII that USG accurately diagnosed 27 patients with PAS out of 32 patients who had PAS (diagnosed per-operatively).

Table 8: Sensitivity, specificity, PPV, NPV and accuracy of USG with 95% confidence interval for diagnosis of PAS

Statistics	Value	95 % Confidence Interval
Sensitivity	84.38%	67.21% to 94.72%
Specificity	75.00%	34.91% to 96.81%
PPV	93.10%	80.11% to 97.84%
NPV	54.55%	32.81% to 74.68%
Accuracy	82.50%	67.22% to 92.66%

Color Doppler ultrasonography can diagnose PAS during the antenatal period with 84.38% sensitivity (95% Confidence Interval: 67.21% to 94.72%), 75.00% specificity (95% Confidence Interval: 34.91% to 96.81%), and 82.50% accuracy (95% Confidence Interval: 67.22% to 92.66%).

DISCUSSION

The clinical condition known as placenta accreta spectrum disorder (PASD), or abnormally invasive placenta (AIP), occurs when the placenta does not separate on its own after birth and cannot be removed by force without producing severe and potentially fatal problems [10, 11]. The incidence of placenta accreta spectrum (PAS) is rising worldwide, largely due to the increasing rates of cesarean deliveries and other uterine surgeries, which are recognized risk factors for abnormal placental attachment [12, 13]. PAS is one of the most dangerous conditions of pregnancy as it is significantly associated with maternal morbidity and mortality [14]. Previous studies have suggested that placenta previa is often a risk factor for placenta accreta [15].

In our study, among the patients with parity 23, about 95.2% were suffering from placenta accreta spectrum. On the other hand, only 63.2% of the participants with parity <3 Was suffering from placenta accreta spectrum. Among the patients with a history of

CS 22, about 91.7% were suffering from placenta accreta spectrum. Placenta accreta spectrum was observed in 62.5% of subjects with a history of cesarean section CS 2. A study conducted by Varlas et al. reported that all participants with placenta accreta spectrum in their study had a history of cesarean section. In contrast, in our study, only one person had no prior cesarean section [16]. El Gelany *et al.,* reported that maternal age > 32 years, previous cesarean section (2), and multiparity (23) are risk factors for placenta accreta spectrum [17]. A study conducted by Gao *et al.,* also reported that Parity, previous curettage, and CS were independent risk factors [18]. Our study's findings on the association between parity (23) and cesarean section (CS) (22) with placenta accreta spectrum align with those of El Gelany *et al.,* and Gao *et al.,* [17, 18].

The majority of patients (85%) underwent emergency cesarean sections in our study. We performed peripartum hysterectomies in approximately 87.5% of the cases, and in the remaining 12.5% of cases, the uterus was preserved. Varlas *et al.,* reported that in approximately 8.33% of cases, they were able to maintain the uterus, which is similar to our study findings (12.5%) [16]. In the PAS pre-group, 76.9% of patients underwent total hysterectomy & 23.1% of patients underwent total hysterectomy [19]. According to Elmaraghy *et al.,* 85% of the PAS group had a cesarean hysterectomy, indicating that hysterectomy is the usual treatment for PAS cases [20]. The primary adverse outcomes of PAS include significant postpartum haemorrhage (PPH) and high hysterectomy rates among women of reproductive age [21]. In several recent series, placenta accreta has emerged as the primary indication for postpartum hysterectomy, accounting for 40-60% of cases [22].

In our study, the proportion of bladder injury was slightly higher (21.9%), most likely due to the increased proportion of placenta percreta among participants. On the other hand, Friedrich *et al.,* reported that the incidence of bladder injury was 9.3% during PAS operations, which was lower than our study [23]. El Gelany *et al.,* found bladder injury in about 39.5% [17]. In other studies, Haba RM *et al.,* reported intraoperative urinary bladder injury was 53.8% [19]. So, our findings were supported by many studies, which reported that complications after cesarean hysterectomy were higher with bladder injury.

In our study, the mean number of units of blood transfusion required for management was 3.03±0.82 units among 80% of patients. In another study, Badr DA *et al.,* stated that up to 50% of patients required blood transfusions of 4 units or more [24]. Five packed red blood cell units were needed on average for transfusion. The diagnosis of PAS before birth and the management of the woman by a multidisciplinary team with knowledge of the illness often enhance maternal and newborn outcomes.

In this study we found that color doppler ultrasonography can diagnose PAS during the antenatal period with 84.38% sensitivity (95% Confidence Interval: 67.21% to 94.72%) and 75.00% specificity (95% Confidence Interval: 34.91% to 96.81%) and 82.50% accuracy (95% Confidence Interval: 67.22% to 92.66%). Gulati *et al.,* reported that ultrasonography can diagnose PAS with a sensitivity of 94.7%, specificity of 87.1%, positive predictive value of 81.8%, and negative predictive value of 96.4% [25]. An intraindividual assessment by Thiravit *et al.,* reported in the US that the findings with the highest accuracy for severe PAS were placental bulge (85.5%), which had a sensitivity of 91.7% and specificity of 76.9% [26]. A systematic review by Maged *et al.,* reported an overall sensitivity of 87.03% and a specificity of 86.34%, which is similar to our study findings [27].

For the examination of pregnant patients, ultrasound is essential and recommended by the World Health Organization. Based on the discussion mentioned above, it is clear that PAS detection can be a crucial tool, making the surgical team more cautious and prepared for challenging procedures and vital postoperative care. It may be trusted as the only method to correctly rule out PAS in patients who test negative, eliminating unnecessary distress among patients owing to a potential hysterectomy.

Limitations of the study

This was a single-center study with a small sample size, which may limit the generalizability of the results. Ultrasound examinations were performed by different sonologists at various centers, which could lead to interobserver variability in diagnosing the placenta accreta spectrum. The use of purposive sampling may have introduced selection bias. Additionally, histopathological confirmation of the placenta accreta spectrum was not performed.

CONCLUSION

About four-fifths of the study participants with placenta previa were suffering from placenta accreta spectrum (PAS). Patients with higher parity [23] and history of cesarean section [22] were found to be significantly associated with PAS. Placenta increta and percreta were prevalent among the participants. Four-fifths of participants needed peripartum hysterectomy, and more than one-fifth required urinary bladder repair. For the antenatal diagnosis of PAS, color Doppler ultrasonography is feasible with a sufficient level of accuracy, and it can be used to identify high-risk patients and implement a preventive strategy for placenta accreta spectrum in patients with placenta previa.

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Conflicts of interest: There are no conflicts of interest.

Ethical approval: The study was approved by the Institutional Ethics Committee.

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