Journal of Medicine in Scientific Research

Volume 5 | Issue 3 Article 9

Subject Area:

Placenta accreta index as a predictor of placental invasion in cases of placenta previa

Ahmed A. Badr
Shibin El Kom Teaching Hospital

Ibrahim M. El-Maghraby
Shibin El Kom Teaching Hospital, ibrahim_mohie@yahoo.com

Recommended Citation

Badr, Ahmed A. and El-Maghraby, Ibrahim M. (2022) "Placenta accreta index as a predictor of placental invasion in cases of placenta previa," *Journal of Medicine in Scientific Research*: Vol. 5: Iss. 3, Article 9.
DOI: https://doi.org/10.4103/jmisr.jmisr_9_21

Original Article

Placenta accreta index as a predictor of placental invasion in cases of placenta previa

Ibrahim M. El-Maghraby, Ahmed A. Badr

Department of Obstetrics and Gynecology, Shibin El Kom Teaching Hospital, Shibin El Kom, Egypt

Abstract

Objective

This study aims to evaluate the role of the placenta accreta index in predicting placental invasion in patients with placenta previa.

Patients and methods

This study was carried on 60 pregnant women with placenta previa (after 30 weeks gestation). They were recruited from the Obstetrics and Gynecology clinic of Menoufia University hospitals and Shebin El Kom Teaching Hospital in the period from January 2019 to December 2020.

Results

Preterm labor was found in 15 (78.95%) patients in the accreta group and six (14.36%) patients in the nonaccreta group (P = 0.000). Hysterectomy was performed in 14 (73.68%) patients in the accreta group and four (9.76%) patients in the nonaccreta group (P = 0.000). Urological complications occurred in five (26.32%) patients in the accreta group and one (2.44%) patient in the nonaccreta group (P = 0.004). Blood transfusion was needed in 16 (84.21%) patients in the accreta group and seven (17.07%) patients in the nonaccreta group (P = 0.000). ICU transfer was needed in 10 (52.63%) patients in the accreta group and two (4.88%) patients in the nonaccreta group (P = 0.000).

Conclusions

Both grayscale and color Doppler ultrasound were very important in the prenatal diagnosis of placenta accreta to reduce maternal and perinatal mortality and morbidity, but color Doppler had higher sensitivity and specificity. Placenta accreta index score 4 can be used as a predictive cutoff value for prediction of placental invasion in patients with placenta previa. Placenta previa in current pregnancy, previous uterine scar, increased maternal age, number of dilation and curettage and number of pregnancies and labors, and the presence of previous history of placenta previa are all risk factors for placenta accreta, and placenta accreta is associated with increased postoperative morbidity. It is associated with increased blood loss, risk of blood transfusion, ICU admissions, wound sepsis, urological complications, and poor neonatal outcome.

Keywords: Accreta index, placenta accreta, placenta previa, placenta, placental invasion, uterine

Introduction

Morbidly adherent placenta is a condition in which all or part of the placenta is adherent to the uterine wall because of myometrial invasion [1]. Morbidly adherent placenta complicates as many as 1 per 500 pregnancies [2]. Morbidly adherent placenta includes placenta accreta, increta, and percreta as it penetrates through the decidua basalis then through the myometrium. For ease of description, the term accreta is used for all these conditions [3]. In addition to previous cesarean section (CS), maternal age over 35 years, multiparity, previous curettage, and placenta previa are risk factors associated with morbidly adherent placenta [4].

Access this article online

Quick Response Code:

Website: www.jmsr.eg.net

DOI: 10.4103/jmisr.jmisr_9_21

This condition is often diagnosed during CS, upon placental removal, with unfavorable maternal outcome. Attempts to remove the placenta can cause severe uterine bleeding. An accurate prenatal diagnosis is required to reduce the risk of maternal/fetal morbidity and mortality [5]. Antenatal diagnosis

Correspondence to: Dr. Ibrahim M. El-Maghraby, MD, Fellow of Obstetrics and Gynecology in Shebin Elkom Teaching Hospital, Shibin El Kom, Egypt.
Postal/Zip Code: 048; Tel (Office): 0482327854; Fax: 0482327854;
E-mail: ibrahim_mohie@yahoo.com

Submitted: 25-Jan-2021 **Revised:** 13-Mar-2021 **Accepted:** 16-Jun-2021 **Published:** 23-Nov-2022

How to cite this article: El-Maghraby IM, Badr AA. Placenta accreta index as a predictor of placental invasion in cases of placenta previa. J Med Sci Res 2022;5:254-60.

of placental invasion has the potential to improve maternal and fetal outcomes [6]. Sonography with grayscale and color Doppler imaging is the recommended first-line modality for diagnosing morbidly adherent placenta [7]. Myometrial involvement greater than 1 mm with large placental lakes on Doppler ultrasound predicts myometrial invasion [1].

The diagnosis of morbidly adherent placenta involves a number of different ultrasound variables, some qualitative and others that have been quantified. These markers include an inability to visualize the normal retroplacental clear zone, irregularity and attenuation of the uterine–bladder interface, retroplacental myometrial thickness, presence of intraplacental lacunar spaces, and bridging vessels between the placenta and the bladder wall when using color Doppler [8]. The approach to management included various procedures like obstetric hysterectomy, internal iliac artery ligation, uterine ligation, sewing placental bed, leaving placenta in situ, B-Lynch suture, uterine packing, pelvic packing, and wedge resection of the uterus [9].

A predictive equation consisted of a group of variable parameters found to lead to significant improvement in the prediction of morbidly adherent placenta, termed the placenta accreta index (PAI). Each parameter was weighted to create a nine-point scale in which a score of 0–9 provided a probability of invasion that ranged from 2 to 96%, respectively [10].

Therefore, this study aims to evaluate the role of the PAI in predicting placental invasion in patients with placenta previa.

Patients and Methods

This study was carried on 60 pregnant women with placenta previa (after 30 weeks of gestation). They were recruited from the Obstetrics and Gynecology clinic of Shebin El Kom Teaching Hospital in the period from January 2019 to December 2020.

Ethical consideration

The institutional committee's ethical criteria were followed during all proceedings. The Shebin Elkom Teaching Hospital's Local Medical Ethics Committee approved the study. Following an explanation of the purpose, procedures, and nature of the study to all participants, signed informed consent was obtained from each participant.

Inclusion criteria

Patients diagnosed with placenta previa in all forms, gestational age in the third trimester, with or without previous CS or any uterine scar, and with or without mild bleeding were included in this study.

Exclusion criteria

Severe bleeding.

Methods

This study was a prospective study. All patients were subjected to the following:

Complete assessment of history, full general and abdominal examination, full laboratory investigations (complete blood count, ABO, Rh and random blood sugar), and full imaging investigations (for each patient, the whole placenta was scanned in a systematic manner using both grayscale ultrasound and color flow mapping. The placenta was imaged with a sufficient bladder volume to clearly visualize the serosa–bladder interface, and the angle of insonation was maintained as low as possible).

Transabdominal grayscale ultrasound

Transabdominal ultrasound was performed for the patients using the Voluson 730 Pro V machine (GE Healthcare Austria GmbH & Co OG. Model: Voluson E8, Atlanta, USA) medical machine, equipped with a 3.5 MHz sector transducer for TAS, the women were placed in a supine position and ultrasound examination was performed with the bladder partially filled, which allows optimal visualization of the uterine serosa and the bladder wall. Ultrasound detects fetal viability, fetal maturity, fetal age, and location of the placenta.

Color Doppler imaging

Doppler was used to assess abnormal vasculature.

Placenta accreta index

The PAI is a predictive equation used in the imaging findings to detect significant improvement in the prediction of placenta accreta. Each parameter was weighted to create a nine-point scale, in which a score of 0–9 provided a probability of invasion that ranged from 2 to 96%, respectively.

Cesarean section

All the women enrolled in this study had undergone CS; the definitive diagnosis of placenta accreta was made at delivery when the myometrium was seen to be invaded by the placenta.

Pathological examination

The hysterectomy specimens were sent for pathological confirmation of the presence of morbidly adherent placenta.

Statistical analysis

Results were analyzed and tabulated using Microsoft Excel 2016 and SPSS v. 21. (SPSS Inc., Chicago, Illinois, USA). Percentage (%), mean, and SD were calculated. Analytical tests were χ^2 and Fisher exact tests. An unpaired t test was used to compare two groups in terms of quantitative variables. A value of P value less than 0.05 was considered to be statistically significant.

Results

In our study, patients with placenta accreta were significantly older than patients with nonaccreta placenta previa ($P = 0.005$). The number of pregnancies was significantly higher in accreta than nonaccreta patients ($P = 0.000$). Also, the decreased number of labors was associated with decreased incidence of placenta accreta ($P = 0.000$). Table 1 shows the relation between placenta accreta and previous obstetric history.

This study shows that there were no significant differences between accreta and nonaccreta patients in terms of number of abortions, the previous history of antepartum

hemorrhage, and the previous history of normal vaginal delivery; the number of previous CS was significantly higher in nonaccreta patients (P = 0.000) while the number of previous dilation and curettage was significantly higher in accreta patients (P = 0.001). The previous history of placenta previa was significantly higher in accreta patients (P = 0.000) (Table 2).

In our study, there was no significant difference between accreta and nonaccreta patients in terms of the time of CS. The placenta previa type was centralis in all accreta patients, while in nonaccreta patients, it was lateralis in 14 patients, marginalis in 10 patients, and centralis in 17 patients. The difference was significant (P = 0.000) (Table 3).

Also, preterm labor was found in 15 (78.95%) patients in the accreta group and six (14.36%) patients in the nonaccreta group (P = 0.000). Hysterectomy was performed in 14 (73.68%) patients in the accreta group and four (9.76%) patients in the nonaccreta group (P = 0.000). Urological complications occurred in five (26.32%) patients in the accreta group and one (2.44%) patient in the nonaccreta group (P = 0.004). Blood transfusion was needed in 16 (84.21%) patients in the accreta group and seven (17.07%) patients in the nonaccreta group (P = 0.000). ICU transfer was needed in 10 (52.63%) patients in the accreta group and two (4.88%) patients in the nonaccreta group (P = 0.000) (Table 4).

By pathological study, placenta accreta was found in three (21.43%) patients, while placenta percreta was found in six patients. Placenta increta was found in five (35.71%) patients. Table 5 shows the parameters of the PAI among the patients included in the study.

In this study, all the parameters of the PAI were found to be statistically significant. The total score was significantly higher in accreta patients (P = 0.000) (Table 6).

Eighteen patients who had index above 4; 17 of these patients were found to have placenta accreta, while it was found in two

Table 1: Demographic data of the patients included in the study

Demographic data	Accreta (n=19)	Nonaccreta (n=41)	P
Age (years)			
Mean±SD	31.79±4.77	27.76±5.22	0.005*
Range	24-40	20-39	
Gravidity			
Mean±SD	4.26±1.195	2.29±1.616	0.000*
Range	2-6	2-6	
Parity			
Mean±SD	3.32±1.53	1.61±1.41	0.000*
Range	1-6	0-5	

Data are presented as mean±SD, n (%); the Student t test was used.
*Statistically significant at the 95% level of confidence.

Table 2: Previous obstetric history of the patients included in this study

Previous obstetric history	Accreta (n=19)	Nonaccreta (n=41)	P
Abortion			
No abortion	6 (31.58)	22 (53.66)	
One abortion	3 (15.79)	5 (12.20)	
Two abortions	5 (26.32)	6 (14.63)	0.436[a]
Three abortions	5 (26.32)	8 (19.51)	
Previous D&C			
No D&C	9 (26.32)	28 (68.29)	
One D&C	0	5 (12.20)	
Two D&C	4 (21.05)	8 (19.519)	0.001[a]*
Three D&C	6 (31.58)	0	
Previous CS			
No CS	0	8 (19.519)	
One CS	4 (21.05)	10 (24.39)	
Two CS	4 (21.05)	23 (56.10)	0.000[a]*
Three CS	11 (57.89)	0	
History of antepartum hemorrhage			
No	3 (15.79)	13 (31.71)	0.195[a]
Yes	16 (84.21)	28 (68.29)	
Previous normal vaginal delivery			
No delivery	13 (68.42)	28 (68.29)	
1 delivery	3 (15.79)	6 (14.63)	
2-3 delivery	2 (10.53)	7 (17.07)	0.405[a]
>3 delivery	1 (5.26)	0	
History of placenta previa			
No	13 (68.42)	41 (100)	0.000[a]*
Yes	6 (31.58)	0	

Data are presented as n (%). CS, cesarean section; D&C, dilation and curettage. [a]Pearson χ^2 test. *Statistically significant at the 95% level of confidence.

Table 3: Present obstetric history of the patients included in the study

Present obstetric history	Accreta (*n*=19)	Nonaccreta (*n*=41)	*P*
Time of CS			
Emergency	8 (42.11)	12 (29.27)	0.326[a]
Elective	11 (57.89)	29 (70.73)	
Placenta previa types			
Lateralis	0	14 (34.15)	
Marginalis	0	10 (24.39)	0.000[a]*
Centralis	19 (100)	17 (41.46)	

Data are presented as *n* (%). CS, cesarean section. [a]Pearson χ^2 test. *Statistically significant at the 95% level of confidence.

Table 4: Maternal and fetal morbidity among the patients included in the study

Maternal and fetal morbidity	Accreta (*n*=19)	Nonaccreta (*n*=41)	*P*
Preterm labor			
Yes	15 (78.95)	6 (14.63)	0.000[a]*
No	4 (21.05)	35 (85.37)	
Hysterectomy			
Yes	14 (73.68)	4 (9.76)	0.000[a]*
No	5 (26.32)	37 (90.24)	
Urological complications			
Yes	5 (26.32)	1 (2.44)	0.004[a]*
No	14 (73.68)	40 (97.56)	
Blood transfusion			
Yes	16 (84.21)	7 (17.07)	0.000[a]*
No	3 (15.79)	34 (82.93)	
ICU transfer			
Yes	10 (52.63)	2 (4.88)	0.000[a]*
No	9 (47.37)	39 (95.12)	

Data are presented as *n* (%). [a]Pearson χ^2 test. *Statistically significant at the 95% level of confidence.

Table 5: Characteristics of placenta accreta by pathology

Placenta accreta	Number of patients (*n*=14) (%)	*P*
Type		
Accreta	3 (21.43)	
Increta	5 (35.71)	0.607[a]
Percreta	6 (42.86)	

Data are presented as *n* (%). [a]χ^2 goodness-of-fit.

patients with index below or equal to 4. The difference was significant (P = 0.000). The sensitivity, specificity, positive predictive value, and negative predictive value of the index are shown in Table 7 and Fig. 1.

Discussion

The published literature is difficult to interpret because of several problems in the definition, terminology, and diagnosis of this disorder. Panels of experts have published consensus statements that aim to standardize the descriptions and minimum

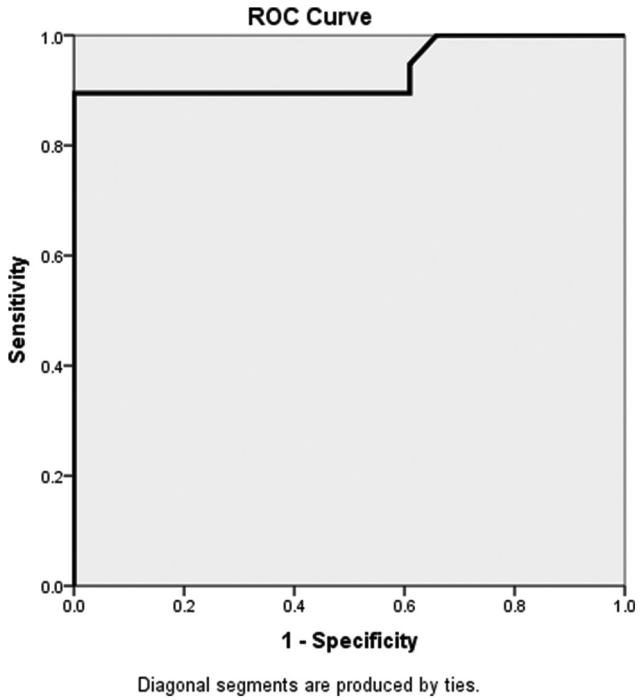

Figure 1: ROC curve of the placenta accreta index in the diagnosis of placenta accreta. ROC, receiver operating characteristic.

requirements for the diagnosis of pacenta accreta spectrum (PAS) [11,12]. In this study, the analysis was carried out using a receiver operating characteristic curve, which indicated that the combination of the smallest sagittal myometrial thickness, intraplacental lacunae, and bridging vessels, in addition to the number of previous cesarean deliveries and placental location (PAI), generates an area under the curve of 0.935. In our study, score 4 was found to be the best cutoff point to diagnose placenta accreta. A total of 18 patients had index above 4; 17 of these patients were found to have placenta accreta, while it was found in two patients with index below or equal to 4. The difference was significant (P = 0.000). The result of our study as well as the study of Weiniger *et al*. [13] indicate that combining diagnostic features associated with PAS disorders through mathematical modeling may improve the accuracy of prenatal diagnosis compared with ultrasound alone. However, like most single-center studies, these may have overestimated the accuracy because they were carried out in centers specialized in prenatal diagnostics, and the overall number of cases of PAS disorders included in these series is small. This study also did not differentiate between adherent and invasive cases, limiting the use of the data in clinical practice. In our study, the sensitivity of score 4 of PAI was 89.5% while the specificity was 97.6%. In agreement with the results of our study, Warshak *et al*. [6] reported that the criteria of abnormal placenta detected by grayscale ultrasound had a sensitivity of 86% and an negative predictive value of 92%. They concluded that visualization of lacunae has the highest sensitivity in the diagnosis of placenta accreta. Similarly, Levine *et al*. [14] reported similar high sensitivity (88%) and specificity (99%) with grayscale ultrasound.

Table 6: Parameters of the placenta accreta index of the patients included in the study

Placenta accreta index	Accreta (n=19)	Nonaccreta (n=41)	P
≥2 cesarean deliveries			
Yes	15 (78.95)	21 (51.22)	0.041[a]*
No	4 (21.05)	20 (48.78)	
Lacunae			
Grade 0	3 (15.79)	20 (48.78)	
Grade 1	5 (26.32)	16 (39.02)	0.001[a]*
Grade 2	3 (15.79)	3 (7.32)	
Grade 3	8 (42.11)	2 (4.88)	
Sagittal smallest myometrial thickness			
≤1 mm	14 (73.68)	5 (12.2)	0.000[a]*
>1 but≤3 mm	5 (26.32)	11 (26.82)	
>3 but≤5 mm	0	25 (60.98)	
Anterior placenta previa			
Yes	14 (73.68)	10 (24.39)	0.000[a]*
No	5 (26.32)	31 (75.61)	
Bridging vessels			
Yes	13 (68.42)	7 (17.07)	0.000[a]*
No	6 (31.58)	34 (82.93)	
Total score			
Mean±SD	5.947±1.992	2.665±1.227	0.000[b]*
Range	2-9	0.25-4.25	

Data are presented as mean±SD, n (%). [a]Pearson χ^2. [b]Student t test. *Statistically significant at the 95% level of confidence.

Table 7: Placenta accreta index more than 4

PAI	Accreta (n=19)	Nonaccreta (n=41)	P	Sensitivity	Specificity	PPV	NPV
Score>4	17 (89.47)	1 (2.44)	0.000[a]*	89.5% (17/19)	97.6% (40/41)	94.44% (17/18)	95.24% (40/42)
Score≤4	2 (10.53)	40 (97.56)					

Data are presented as n (%). NPV, negative predictive value; PAI, placenta accreta index; PPV, positive predictive value. [a]Pearson χ^2 test. *Statistically significant at the 95% level of confidence.

As mentioned in the literature, MRI is considered an adjunctive modality and adds little to the diagnostic accuracy of ultrasound, which is found to be very accurate, and MRI added no additional information in any case, except one, in which the placenta was posterior [7]. Two studies found that the diagnostic value of ultrasound imaging and MRI in detecting placenta accreta is comparable. The first one, published in 2013, included 13 studies, and a sensitivity of 83%, specificity of 95%, and diagnostic odds ratio (DOR) of 63.41 were reported for ultrasound imaging compared with a sensitivity of 82%, a specificity of 88%, and DOR of 22.95 for MRI [13]. The second study included 18 studies and found that in terms of the overall diagnostic accuracy of MRI, a sensitivity of 94.4%, a specificity of 84.0%, and DOR of 89.0 were obtained [15].

In this study, we found that the identification of placenta accreta among women was associated with similar risk factors and adverse maternal outcomes. Placenta previa in the current pregnancy with a history of previous cesarean or previous uterine surgery was significantly more common in the accreta group, which was confirmed by previous studies [16,17] The outcomes with placenta accreta were significantly more likely to have a major hemorrhagic morbidity including postpartum hemorrhage, blood transfusion, hysterectomy, and maternal ICU admission.

Our findings are consistent with those of Roeca *et al*. [18], who found that the risk factors for PAS increase proportionally with the number of previous cesarean deliveries. The incidence rate increases by 28, 32, and100% for the first, second, third, and fourth CS, respectively. Also, this study showed that the maternal age is older in the accreta group than the nonaccreta group, and this is a significant risk factor for PAS, as confirmed by Vinograd *et al*. [19]. In this study, 31% of PAS cases were associated with placenta previa. This is consistent with the findings of Oyelese and Smulian [20]. PAS was associated with adverse maternal outcomes. Preterm labor was found in 15 (78.95%) patients in the accreta group and six (14.36%) patients in the nonaccreta group (P = 0.000). Hysterectomy was performed in 14 (73.68%) patients in the accreta group and four (9.76%) patients in the nonaccreta group (P = 0.000). Urological complications occurred in five (26.32%) patients in the accreta group and in one (2.44%) patient in the nonaccreta group (P = 0.004). Blood transfusion was needed in 16 (84.21%) patients in the accreta group and seven (17.07%) patients in the nonaccreta group (P = 0.000). ICU transfer was needed in 10 (52.63%) patients in the accreta group and two (4.88%) patients in the nonaccreta group (P = 0.000), which is consistent with the study of Mullen *et al*. [16].

In our study, there was no statistically significant difference between adherent and nonadherent placenta in relation to age, gravidity, and parity. This is consistent with Chou *et al*. [8] and Calì *et al*. [21], who reported that there was no statistically significant difference between morbidly adherent placent (MAP) and nonadherent placenta in relation to age, parity, and gravidity, while Jacques *et al*. [22] showed that there was a highly significant difference between placenta accreta and high gravidity. Placenta accreta is associated with intraoperative and postoperative morbidity caused by massive blood transfusion, infection, and adjacent organ damage [7]. 84.2% received blood transfusion, 52.6% were referred to the ICU due to severe complication and for better follow up, and 73.68% needed peripartum hysterectomy. This is consistent with Zelop *et al*. [23], and Robinson and Grobman [24]; 26.32% of the patients had urological complications. Eller *et al*. [3] reported that ureteric stent placement may help to reduce the risk of ureteric injury. Prematurity was the primary neonatal complication associated with placenta accreta. It occurred in 78.95%. This is in agreement with Gielchinsky *et al*. [25]. They found that pregnancies complicated with placenta accreta have increased incidence of preterm deliveries. Comstock *et al*. [26] had found that the presence of lacunae in the placenta at 15–20 weeks of gestation was the most predictive sonographic sign of placenta accreta, with a sensitivity of 79% and a positive predictive value of 92%. These lacunae may give the placenta a 'moth-eaten' or a 'Swiss cheese' appearance. Thus, they serve as useful indicators for the early diagnosis of placenta accreta.

Conclusion

Both grayscale and color Doppler ultrasound were very important in the prenatal diagnosis of placenta accreta to reduce maternal and perinatal mortality and morbidity, but color Doppler had higher sensitivity and specificity. PAI score 4 can be used as a predictive cutoff value for the prediction of placental invasion in patients with placenta previa. Placenta previa in current pregnancy, previous uterine scar, increased maternal age, high number of dilation and curettage and pregnancies and labor, and the presence of a previous history of placenta previa are all risk factors for placenta accrete, and it is associated with increased postoperative morbidity, increased blood loss, risk of blood transfusion, ICU admissions, wound sepsis, urological complications, and poor neonatal outcome.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Roger M, Chang A. Postpartum hemorrhage and other problems of third stage. In: James D, *et al*. *High risk pregnancy*. 4th ed. James DK, Steer PJ, Weiner CP, Gonik B. High risk pregnancy e-book: management options-expert consult. Elsevier Health Sciences; 2011;2:1563-77.
2. Wu S, Kocherginsky M, Hibbard JU. Abnormal placentation: twenty-year analysis. Am J Obstet Gynecol 2005; 192:1458–1461.
3. Eller AG, Bennett MA, Sharshiner M, Masheter C, Soisson AP, Dodson M, Silver RM. Maternal morbidity in cases of placenta accreta managed by a multidisciplinary care team compared with standard obstetric care. Obstetr Gynecol 2011; 117:331–337.
4. Esakoff TF, Sparks TN, Kaimal AJ, Kim LH, Feldstein VA, Goldstein RB, *et al*. Diagnosis and morbidity of placenta accreta. Ultrasound Obstet Gynecol 2011; 37:324–327.
5. Tikkanen M, Paavonen J, Loukovaara M, Stefanovic V. Antenatal diagnosis of placenta accreta leads to reduced blood loss. Acta Obstet Gynecol Scand 2011; 90:1140–1146.
6. Warshak CR, Eskander R, Hull AD, Scioscia AL, Mattrey RF, Benirschke K, Resnik R. Accuracy of ultrasonography and magnetic resonance imaging in the diagnosis of placenta accreta. Obstetr Gynecol 2006; 108:573–581.
7. Committee on Obstetric Practice. ACOG committee opinion. Placenta accreta. Number 266, January 2002. American College of Obstetricians and Gynecologists. Int J Gynaecol Obstetr 2002; 77:77.
8. Chou MM, Ho ES, Lu F, Lee YH. Prenatal diagnosis of placenta previa/accreta with color Doppler ultrasound. J Int Soc Ultrasound Obstetr Gynecol 1992; 2:293–296.
9. Choudry A, Choudry H, Shukr I, Bano I, Ahmad S. Impact of antenatal diagnosis and management strategies in morbidly adherent placenta. Pak J Med Res 2011; 50:5.
10. Rac MW, Dashe JS, Wells CE, Moschos E, McIntire DD, Twickler DM. Ultrasound predictors of placental invasion: the Placenta Accreta Index. Am J Obstet Gynecol 2015; 212:343–e1.
11. Alfirevic Z, Tang AW, Collins SL, Robson SC, Palacios-Jaraquemada J. Pro forma for ultrasound reporting in suspected abnormally invasive placenta (AIP): an international consensus. Ultrasound Obstetr Gynecol 2016; 47:276–278.
12. Collins SL, Ashcroft A, Braun T, Calda P, Langhoff-Roos J, Morel O, *et al*. Proposal for standardized ultrasound descriptors of abnormally invasive placenta (AIP). Ultrasound Obstetr Gynecol 2016; 47:271–275.
13. Weiniger CF, Einav S, Deutsch L, Ginosar Y, Ezra Y, Eid L. Outcomes of prospectively-collected consecutive cases of antenatal-suspected placenta accreta. Int J Obstet Anesth 2013; 22:273–279.
14. Levine D, Barnes PD, Edelman RR. Obstetric MR imaging. Radiology 1999; 211:609–617.
15. D'Antonio F, Bhide A. Ultrasound in placental disorders. Best Pract Res Clin Obstetr Gynaecol 2014; 28:429–442.
16. Mullen C, Battarbee AN, Ernst LM, Peaceman AM. Occult placenta accreta: risk factors, adverse obstetrical outcomes, and recurrence in subsequent pregnancies. Am J Perinatol 2019; 36:472–475.
17. Jauniaux E, Collins S, Burton GJ. Placenta accreta spectrum: pathophysiology and evidence-based anatomy for prenatal ultrasound imaging. Am J Obstet Gynecol 2018; 218:75–87.
18. Roeca C, Little SE, Carusi DA. Pathologically diagnosed placenta accreta and hemorrhagic morbidity in a subsequent pregnancy. Obstetr Gynecol 2017; 129:321–326.
19. Vinograd A, Wainstock T, Mazor M, Beer-Weisel R, Klaitman V, Dukler D, *et al*. Placenta accreta is an independent risk factor for late pre-term birth and perinatal mortality. J Mater Fetal Neonat Med 2015; 28:1381–1387.
20. Oyelese Y, Smulian JC. Placenta previa, placenta accreta, and vasa previa. Obstetr Gynecol 2006; 107:927–941.
21. Calì G, Giambanco L, Puccio G, Forlani F. Morbidly adherent placenta: evaluation of ultrasound diagnostic criteria and differentiation of placenta accreta from percreta. Ultrasound Obstet Gynecol 2013;

41:406–412.
22. Jacques SM, Qureshi F, Trent VS, Ramirez NC. Placenta accreta: mild cases diagnosed by placental examination. Int J Gynecol Pathol 1996; 15:28–33.
23. Zelop CM, Harlow BL, Frigoletto JrFD, Safon LE, Saltzman DH. Emergency peripartum hysterectomy. Am J Obstet Gynecol 1993; 168:1443–1448.
24. Robinson BK, Grobman WA. Effectiveness of timing strategies for delivery of individuals with placenta previa and accreta. Obstetr Gynecol 2010; 116:835–842.
25. Gielchinsky Y, Rojansky N, Fasouliotis SJ, Ezra Y. Placenta accreta—summary of 10 years: a survey of 310 cases. Placenta 2002; 23:210–214.
26. Comstock CH, Love JrJJ, Bronsteen RA, Lee W, Vettraino IM, Huang RR, Lorenz RP. Sonographic detection of placenta accreta in the second and third trimesters of pregnancy. Am J Obstet Gynecol 2004; 190:1135–1140.