COMPARISON BETWEEN INTRAOPERATIVE FEATURES OF MORBIDLY ADHERENT PLACENTA WITH PRENATAL ULTRASONIC FEATURES

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ABSTRACT

Background

The term morbidly adherent placenta characterized by abnormally implanted, invasive, or adhered placenta, which is increasing in obstetrical practice mainly due to increasing rate of cesarean section associated with increasing mortality and morbidity which can be avoidable by good assessment by ultrasound before operation.

Objectives

The aim of this study was to assess the diagnostic accuracy of pre-natal ultrasound in detecting morbidly adherent placenta in patients at risk.

Materials and Methods

Prospective observational study, case sheets of 125 women reviewed having placenta previa and previous uterine surgery (CS, myomectomy or curettage) from May 2018 to May 2019, population included 38 pregnant women. All cases of complete placenta previa or low-lying placenta, scans performed through either trans abdominal ultrasonography or transvaginal ultrasonography in their second and third trimesters of pregnancy, signs were loss of clear zone, placental lacunae, myometrial thinning, placental bulge, focal exophytic mass, and bladder wall interruption with the availability of more than three finding regarded as highly suspicious and final diagnosis made during cesarean section.

Results

Among 38 patients with risks, there was a significant correlation between increasing age and extend of morbidly adherent placenta. The average gestational age of the patients was 36.2 weeks, ranging from 20-39.3 weeks. All cases at least underwent prior caesarean delivery. There was increasing incidence of MAP with increasing number in C/S. In women with risk of MAP along with highly suspicious ultrasound findings, fourteen cases underwent hysterectomy, uterus-sparing alternatives to manage this condition can be an option in selected cases, the most reliable signs for suspecting percreta were placental bulge, focal exophytic mass, and bladder wall interruption, the sensitivity and positive predictive value was 70% and 90% respectively.

Conclusion

Management with prediction of MAP by ultrasonography is useful for obtaining permissible morbidity.

Keywords: *Morbidly adherent placenta (MAP), Placenta accreta, increta, percreta, Ultrasound imaging, Prenatal diagnosis, Cesarean section (C/S).*

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INTRODUCTION

The term morbidly adherent placenta describes aberrant placentation characterized by abnormally implanted, invasive, or adhered placenta. It is referring to these disorders collectively as accrete syndromes and use these terms interchangeably. Derivation of accrete comes from the Latin ac-+crescere-zto adhere or become attached to [1] which is a rare but potentially life threatening complication of pregnancy and it is one of the major causes of massive obstetric hemorrhage; with the increasing rate of cesarean delivery, the incidence of both placenta previa and placenta accreta is steadily increasing in frequency [2, 3]. In the accrete syndromes, abnormal placental adherence to the myometrium stem in part from partial or total absence of the decidua basalis and imperfect development of the fibrinoid or nitabuch layer, if the decidual spongy layer is lacking either partially or totally, then the physiological line of cleavage is absent, and some or all cotyledons are densely anchored. Microscopically, placental villi attach to smooth muscle fibers rather than to decidual cells. This decidual deficiency then prevents normal placental separation after delivery. The surface area of the implantation site involved and the depth of trophoblastic tissue ingrowth are variable between women, but all affected placentas can potentially cause significant hemorrhage [4].

Substantiated data now suggest that accrete syndromes are not solely caused by this anatomical layer deficiency [5] indeed, the cytotrophoblasts may control decidual invasion through factors such as angiogenesis [6], also, accrete syndrome tissue show" hyperinvasiveness" [7]. Myometrial fibers attached to the basal plate in an antecedent pregnancy are predictive markers for a subsequent placenta accreta [8, 9], which is "constitutional endometrial defect" in most cases. The greater risk conveyed by previous surgical uterine trauma may be partially explained by an enhanced vulnerability to trophoblast invasion [10]. This association with prior trauma is reinforced by the close relationship between cesarean-scar pregnancy (CSP) and later development of placenta accreta in the same pregnancy. Indeed, occurring evidence suggests that CSP and accrete syndrome lie on a spectrum and that CSP is a precursor, as both share the same histopathology [11].

The grading classification of MAP are classified by the depth of trophoblastic growth was introduced by modern pathologists in 1960s [1]. Placenta accrete indicates that villi are attached to the myometrium. With placenta increta, villi actually invade the myometrium, and placenta percreta defines villi that penetrate through the myometrium and to or the serosa [12]. In all three varieties, abnormal adherence may involve all lobules-total placenta accrete. If all or part of a single lobule is abnormally attached, it is described as a focal placenta accreta. These are similar in many aspects to those for placenta previa. That said, the two most important risk factors are an associated previa, a prior cesarean delivery, and more likely a combination of the two [13]. A classical cesarean incision has a higher risk a subsequent accrete placenta [14]. In fact, almost half of women with a prior cesarean delivery had myometrial fibers seen microscopically adhered to the placenta [9].

Dysfunctional decidual formation also may follow any other type of myometrial trauma such as curettage or endometrial ablation [1, 15]. Even without a prior hystorotomy, coexisting placenta previa is additive to frequency, a shorter cervical length with placenta accrete did not confer a greater risk for preterm delivery [16]. Ideally, ultrasonographic findings is used for antepartum identification of abnormal placental ingowth [17, 18]. In 2016, The European Working Group on Abnormally Invasive Placenta proposed standardized descriptions of ultrasound signs used for the prenatal diagnosis of MAP [19].

Loss of the clear zone is used when the normal hypoechoic retroplacental zone in the myometrium under the placental bed is not visible on ultrasound, which is shown in Figure (2) It was one of the first signs identified by grayscale ultrasound imaging in cases of MAP, this sign is supposed to represent an abnormal extension of the placental villi through the decidua basalis into the myometrium. As pregnancy advances, the decidual layer becomes thinner and discontinuous and the myometrium will also become thinner and more heterogeneous due to the progressive dilatation of the uteroplacental circulation. These layers generate an echolucent ultrasound signal under the placenta. In addition, it will also change with the location of the placenta inside the uterine cavity, direct pressure of the ultrasound probes, and/or filling of the bladder and may be obscured by the amount of scar tissue present. [17]. Myometrial thinning to <1 mm, or to where the myometrium becomes undetectable on ultrasound, has been used as a prenatal diagnostic sign for MAP [20, 21], but it is only reported in 50% of cohort studies [17]. This can be seen when the placenta develops underneath a major scar defect, where the myometrium is thinner than normal or completely replaced by scar tissue.

This thinning effect is more pronounced in the third trimester, in particular, >32-34 weeks.

Placental lacunae are numerous, large, irregular sonolucent intraplacental spaces often described on ultrasound [22] giving the placenta a "moth-eaten" appearance in MAP in both transabdominal and trans vaginal ultrasound. Other terms have been used to describe these spaces including "placental lakes [23] and "Swiss cheese [24] the shape and number of lakes will vary with gestational age, with the location of the placenta inside the uterine cavity, and with direct pressure of the ultrasound probes which is shown in figure1. This is often described on gray-scale ultrasound as an interruption, loss, or irregularity of the bladder wall or of the hyperechoic line between uterine serosa and bladder lumen [25]. Placental bulge describes the ballooning of the uterus containing the placenta away from its expected plane into the surrounding tissue, usually the bladder [26]. Exophytic mass describes the invasion of the villous tissue through the myometrium and the serosa into adjacent extrauterine organs, usually the bladder. This focal exophytic mass of placental tissue, extending beyond the uterine serosa, should only occur in cases of Placenta previa [17].

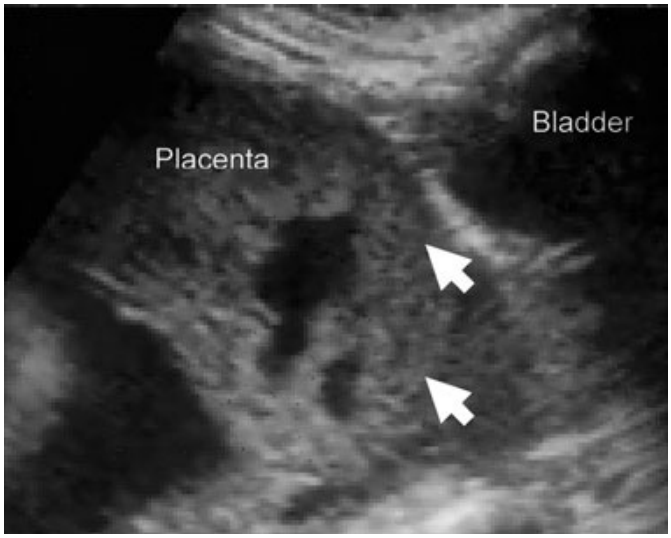

Figure 1. Ultra-sonographic image of placenta previa showing a loss of the Accreta with multiple placental lakes (white arrows).

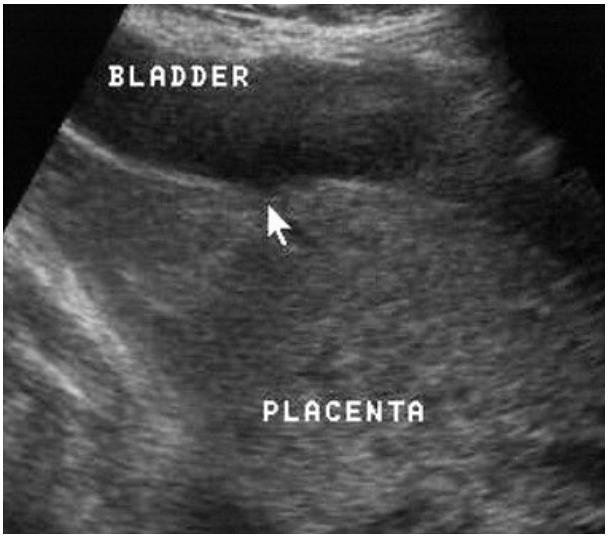

Figure 2. The white arrow is visible clear zone .

MATERIALS AND METHODS

The approval for this study obtained from a constituted Ethical Committee, which was done through prospective observational study case sheets of 125 women reviewed having placenta previa and previous uterine surgery (CS, myomectomy or curettage) from May 2018 to May 2019 and whom referred for suspected placenta accreta and admitted to the Maternity Teaching Hospital, Sulaimani, Kurdistan Region, Iraq. Study population included thirty-eight patients. All cases of complete placenta previa or low-lying placenta. Placenta was defined as low lying if the leading placental edge was within 20 mm from the internal os (3) were performed by radiologists experienced in, confirmed through either trans-abdominal ultrasonography or transvaginal ultrasonography in their second and third trimesters of pregnancy (between 16 and 36 weeks) using two-dimensional (2D) gray-scale imaging the following: Loss of clear zone, Placental lacunae, Bladder wall interruption, Myometrial thinning, Focal exophytic mass, Placental bulge.

Diagnostic suspicion of MAP was supported by the presence of at least two criteria, and clinical diagnosis was made upon CS, during the study period, patients with placenta previa were managed depending on both risk and the prediction of MAP by ultrasonography. Risks for MAP included age, history of cesarean delivery, and history of prior uterine surgery.

In the group with risks for MAP, women who had all three findings (myometrial thinning, absence of the retroplacental clear zone, and placental lacunae) were regarded as highly suspicious for MAP. Inclusion criteria included: patients with singleton pregnancy, placenta previa anterior with at least one previous cesarean delivery, and the gestational age more than 20 weeks' history of any uterine surgery. Exclusion criteria: multifetal pregnancies patients with unscarred uterus, Patients with normally situated placenta. Those with coagulopathy, All the women in this study were subjected to Full history taking and examination, Laboratory investigations (Pre-operative ,complete blood count, coagulation profile, liver functions ,renal functions, blood glucose), Basic demographic and pregnancy information, including, age, ,parity, gestational age was also retrieved and information regarding morbidity associated with the surgical procedure, and use and volume of transfusion of blood products Planned operations were performed. all elective and emergency cases of MAP included which performed by obstetricians experienced in cesarean hysterectomy in the presence of anasthiologist expert in obstetric anesthesia, experienced vascular surgeon and urologist and neonatologist.

The uterine incision was then performed, following delivery of the fetus and clamping of the cord, Intraoperative data recorded were Placental site, spontaneous separation or non-separation, placental invasion into the bladder and other surrounding organs, in this situation no attempt to remove the placenta manually when it was evident that the placenta had reached the uterine serosa. In the event of failed placental detachment, hysterectomy was performed, preserving the adnexa Clinical outcomes were evaluated by recording the findings of the obstetricians themselves at the time of delivery or from the histopathological reports when available

Uterotonic administration, uterine devascularisation procedures, blood loss and blood transfusion, Occurrence of coagulopathy or not then Postoperative data were also recorded especially Intensive care unit admission> 24hr, intra and post-operative blood loss and transfusion, which defined as early morbidity.

We used "IBM SPSS statistics version 25" "(Statistical Package for the Social Science) for the analysis of the data. Moreover, a P-value of (<0.05) we considered as statistically significant, and a P-value of (<0.001) as spastically very highly significant. In addition, Pearson Chi-square (2) test was used to find out the significance of association between independent and dependent variable pairs, and Pearson R Correlation was used to calculate the direction of the correlation between the two variables.

RESULTS

During 1 year study, which is done in Maternity Teaching Hospital (Sulamani, Kurdistan region, Iraq) with annual number of deliveries 16786, we enrolled 125 pregnant women with diagnosis of placenta previa major (placenta lying over the internal cervical os) or placenta previa minor (leading edge of the placenta in the lower uterine segment but not covering the cervical os). Out of these 38 patients were confirmed to have MAP. The average age of patients was 34.6 years with 14 patients more than 35 years and 3 patients more than 41 years of age ranging from 27-42 year. 76.3% were from rural area and 23.7% were from the urban area. The average gestational age of the patients was 36.2 weeks, ranging from 20-39.3 weeks. The risk factors included

all cases at least underwent prior caesarean delivery and 14 cases had prior surgical uterine evacuation (uterine curettage) and one case of metroplasty done for uterine anomaly in women (which is shown in Table 1) with risk of MAP along with the ultrasound finding of either placenta previa or low lying placenta in 28 of 38 cases on US scan. Ultrasound findings that were suspicious for a placenta accrete were noted at least on one scan, 14/38 patients with MAP undergoing hysterectomy. Of the women not undergoing hysterectomy treatments included; B-Lynch suture (4 cases), intra-uterine balloon catheter (12 cases), internal iliac artery ligation (1 case), Wedge resection of lower segment 1 case, with the most reliable signs intraoperatively. For suspecting percreta were placental bulge, focal exophytic mass, and bladder wall interruption, the sensitivity and PPVis 100% and 62%respectively for each of loss of clear zone & myometrial thinning for placenta accrete, but for placental lacunae is 70% and 90% respectively.

Table 1. The patient's baseline characteristics.

Patients' characteristics		Mean±SD	Mode	Range
Age (year)		34.6 ±4.3	37	27 to 42
Gestational age (week)		34.7±4.5	37	20 to 39
Gravida		4.8±1.3	5	2 to 8
Residency	Inside city		9 (23.7%)	
	Outside city		29 (76.3%)	
	Total		38 (100%)	
Number of previous C/S	1	7 cases	18.4%	
	2	7 cases	18.4%	
	3	17 cases	44.7%	
	4	5 cases	13.1%	
	5	2 cases	5.2%	
Mode of conception	Spontaneous		37 (97.4%)	
	IVF		1 (2.6%)	
	None		24 (63.2%)	
Number of previous surgical evacuation	1		10 (26.3%)	
	2		4 (10.5%)	
History of previous abnormal invasive placenta	No		38 (100%)	
Previous uterine surgery	No		37 (97.3%)	
	Metroplasty		1 (2.6%)	

C/S = cesarean section; IVF = in vitro fertilization; SD = standard deviation

Table 2. The association between age of the patients and extend of MAP.

Age (year) group	Extend of abnormally invasive placenta (MAP)		Total	P-value (Pearson's R Correlation)
	Focal	Diffuse		
27-30	8	1	9	
31-35	5	7	12	
36-40	10	4	14	0.018 (0.274)
41-42	0	3	3	
Total	23	15	38	

Table 3. The association between number of caesarian section and MAP.

Number of previous C/S		Outcome (type of placenta)			Total NO.C/S	P-value (Pearson's R Correlation)
		Placenta accreta	Placenta increta	Placenta percreta		
1	Count	5	2	0	7	0.05 (0.343)
	% of Total	13.2%	5.3%	0.0%	18.4%	
2	Count	3	3	1	7	
	% of Total	7.9%	7.9%	2.6%	18.4%	
3	Count	5	8	4	17	
	% of Total	13.2%	23%	10.5%	44.7%	
4	Count	3	2	0	5	
	% of Total	7.9%	5.3%	0.0%	13.2%	
5	Count	1	1	0	2	
	% of Total	2.6%	2.6%	0.0%	5.3%	
Total u/s finding	Count	17	16	5	38	
	% of Total	44.7%	42.1%	13.2%	100.0%	

Table 4. Maternal outcomes according to ultrasonographic findings.

No.of u/s finding	0-1 (low)	2 (intermediate)	3 (high)	P value
n=38	7	8	23	
Maternal out comes				
Emergency c/s	7	7	22	0.32
Hysterectomy	1	1	12	0.24
Estimated blood loss (ml)	1150 ± 500	1370 ± 800	2180 ± 1438	0.09
Blood transfusion	3	7	9	0.6
Hospital stay duration	2 (1-3)	4 (2-6)	5 (3-8)	0.7

Table 5. The association between probability of MAP and abnormal placental lacunae (sonographically).

Probability of clinically MAP	Abnormal placental lacunae			Total	P-value (Pearson's R Correlation)	Sensitivity	PPV
	Yes	No	Unsure				
High	21	1	1	23		**For accreta 70.6%**	42.9%
Intermediate	1	1	5	7	<0.001 (0.66)	**For increta 75%**	42.9%
Low	0	6	2	8			
Total	22	8	8	38		**Percreta 80.5%**	90%

Table 6. The association between probability of clinically MAP with loss of clear zone sonographically.

Probability of clinically abnormally invasive placenta (AIP)	Loss of clear zone			Total	P-value (Pearson's R Correlation)	Sensitivity	PPV
	Yes	No	Unsure				
High	23	0	0	23			
Intermediate	6	0	1	7	<0.001 (0.841)	100% (29/29)	62% (29/38)
Low	0	2	6	8			
Total	29	2	7	38			

Table 7. The association between probabilities of clinically MAP with myometrial thinning sonographically.

Probability of clinically abnormally invasive placenta (AIP)	Myometrial thinning			Total	P-value (Pearson's R Correlation)	Sensitivity	PPV
	Yes	No	Unsure				
High	23	0	0	23			
Intermediate	6	0	1	7	<0.001 (0.841)	100% (29/29)	62% (29/38)
Low	0	2	6	8			
Total	29	2	7	38			

Table 8. The correlation of ultrasonic features with evidence of MAP

Placental characteristics /outcome		Outcome			P value
		Accreta	Increta	Percreta	
Loss of clear zone	Yes	11	13	5	0.50
	No	1	1	0	
	Unsure	5	2	0	
Myometrium thinning	Yes	10	13	5	0.33
	No	1	1	0	
	Unsure	6	2	0	
Abnormal placental lacunae	Yes	8	10	4	0.37
	No	3	4	1	
	Unsure	6	2	0	
Bladder wall interruption	Yes	1	0	4	< 0.001
	No	15	15	1	
	Unsure	1	1	0	
Placental bulge	Yes	0	0	3	<0.001
	No	17	15	0	
	Unsure	0	1	2	
Focal exophytic mass	Yes	0	0	3	< 0.001
	No	16	17	0	
	Unsure	0	0	2	
Probability of clinically MAP	High	7	11	5	0.14
	Intermediate	6	2	0	
	Low	4	3	0	
Extend of MAP	Focal	15	8	0	0.001
	Diffuse	2	8	5	

DISCUSSION

The aim of the current study was to assess the diagnostic accuracy of pre-natal ultrasound in detecting morbidly adherent placenta in patients at risk. Among the different ultrasound signs of MAP, myometrial thinning, loss of clear zone, placental lacunae were the most repeated but (Focal exophytic mass, Placental bulge , Bladder wall interruption associated with the most severe types of MAP, such as placenta percreta and showed an overall good predictive accuracy. [27]. in clinical practice, cases of placenta previa with the following ultrasonography findings: loss of the retroplacental sonolucent zone (high sensitivity but low specificity) and thin retroplacental myometrium (thickness is difficult to measure accurately) [28]. Gestational age at assessment is another important issue. Because MAP is a progressive condition and it may be entirely possible that the ultrasound appearance of the different ultrasound signs of MAP can change though gestation. The risk of MAP is directly related to the number of previous CS and models integrating pregnancy characteristics and ultrasound signs have been shown to predict MAP [29] Silver and colleagues reported that women with placenta previa have placenta accreta risk of 3%, 11%, 40%, 61%, and 67% for one, two, three, four and five or more prior cesarean

deliveries, respectively [30]. Early prenatal diagnosis is the most important strategy to prevent the adverse outcome with abnormally invasive placenta as it offers the attending physician available time to optimize the preoperative planning, have a birth plan that could assess the expected blood loss and other intra and post-surgical complications associated with this anomaly allowing a pre-planned management of the condition [31] thus minimizing maternal morbidity and mortality [32-34]. Severe types of MAP, such as placenta percreta, are associated with a higher risk of adverse maternal outcomes, such as severe hemorrhage, need for transfusion,and admission to intensive care unit. It is therefore desirable to identify the cases at higher risk of placenta percreta in order to plan an appropriate surgical management [2,3]. The data from the present study review showed that loss of clear zone and myometrial thinning has an overall good accuracy in identifying women affected by placenta arcreta with a sensitivity of 100% and a PPV of 62%.Outcome of women affected by MAP is not only affected by the depth but also by the extent of the invasion [27]. Maged AM et al 2017 [35] found that loss of retroplacental clear zone has sensitivity of 87.30% specificity of 89.19% with over all accuracy of 88%. Recently, multi parametric prediction models integrating imaging signs and pregDnancy characteristics, such as the number of prior CS have been shown to predict MAP more accurately than imaging alone [29]. Japaraj RP et.al 2007 [23] agreed with finding in his research that using grey scale ultrasound had sensitivity of 85% and specificity of 100% in the diagnosis of placenta accrete. With the main feature was the presence of venous lake. According to a report by Comstock et al 2004 [22]. The sensitivity and positive predictive value for the detection for MAP by ultrasonography with any finding, such as absence of the retroplacental clear zone, or presence of placental lacunae,were 100% and 48%, respectively. In order to obtain a high predictive value for the detection of adherent placenta, a combination of multiple findings may be superior, although this approach may not be very sensitive. Shamshirsaz et al. [36] the impact of multidisciplinary protocols on the outcome of placenta accreta and indicated that the multidisciplinary protocol was superior to the nonmultidisciplinary protocol cause.

In conclusions, decreasing maternal morbidity and mortality requires heightened suspicion and surveillance for MAP by U/S Referral to a tertiary care center with multi-disciplinary approach access to specialists in maternal-fetal medicine, surgical subspecialties, anesthesia, transfusion medicine, and intensive care is recommended to ensure optimal outcomes for these complicated patients

REFERENCES

1. Benirschke K, Burton GJ, Baergen RN. Pathology of the human placenta. 6th ed. Berlin: Springer Verlag; 2012.

2. Oyelese Y, Smulian JC. Placenta previa, placenta accreta, and vasa previa. Obstet Gynecol. 2006; 107(4):927-41.

3. Publications Committee SfM-FM, Belfort MA. Placenta accreta. Am J Obstet Gynecol. 2010; 203(5):430-9.

4. Cunningham FG, Leveno KJ, Bloom SL. Obstetrical Hemorrhage. 25th ed. New York, NY: McGraw-Hill Education; 2018.

5. Duzyj CM, Barishansky S, Khan S, et al: Evidence of active wound remodeling at the site of trophoblast invasion in placenta accreta. Abstract No. 1 47, Am Obstet Gynecol 2 1 6:S99, 2017

6. Wehrum M , Buhimschi lA, Salaia C , e t al: Accreta complicating complete placenta previa is characterized by reduced systemic levels of vascular endothelial growth factor and by epithelial-to-mesenchymal transition of the invasive trophoblast. Am Obstet Gynecol 204(5):4 1 1 .e l, 20 11

7. Pri-Paz S, Devine PC, Miller RS, et al: Cesarean hysterectomy requiring emergent thoracotomy: a case report of a complication of placenta percreta requiring a multidisciplinary efort. J Reprod Med 57(1 -2):58, 20 12

8. Linn RL, Miller ES, Lim G, et al: Adherent basal plate myometrial fibers in the delivered placenta as a risk factor for development of subsequent placenta accreta. Placenta 36(1 2):1419, 20 15

9. Miller ES, Linn L, Ernst LM: Does the presence of placental basal plate myometrial ibers in a prior pregnancy improve prediction of placenta accreta? B OG 1 23(13):2 1 40, 2016

10. Jauniaux E, Collins S, Burton GJ. Placenta accreta spectrum: pathophysiology and evidence-based anatomy for prenatal ultrasound imaging. Am J Obstet Gynecol. 2018; 218(1):75-87.

11. Happe SK, Rac MW, Moschos E, et al: Prospective assessment of morbidly adherent placenta with irst trimester ultrasound. Presented at the 38th Annual Meeting of the Society for Maternal-Fetal Medicine, January 29- February 3, 20 18

12. Silver RM. Abnormal Placentation: Placenta Previa, Vasa Previa, and Placenta Accreta. Obstet Gynecol. 2015; 126(3):654-68.

13. Klar M, Michels KB. Cesarean section and placental disorders in subsequent pregnancies--a meta-analysis. J Perinat Med. 2014; 42(5):571-83.

14. Gyamfi-Bannerman C, Gilbert S, Landon MB, Spong CY, Rouse DJ, Varner MW, et al. Risk of uterine rupture and placenta accreta with prior uterine surgery outside of the lower segment. Obstet Gynecol. 2012; 120(6):1332-7.

15. Gill LA, Baldwin E, Lessard-Anderson C, White W. Septic abortion with placenta accreta in pregnancy after endometrial ablation. Obstet Gynecol. 2015; 125(4):822-4.

16. Rac MW, Mcintire DO, Wells CE, et al: Cervical length in patients at risk for placental accreta. Ultrasound Med 36( ):1431, 2017

17. Jauniaux E, Collins SL, Jurkovic D, Burton GJ. Accreta placentation: a systematic review of prenatal ultrasound imaging and grading of villous invasiveness. Am J Obstet Gynecol. 2016; 215(6):712-21.

18. Tam Tam KB, Dozier J, Martin JN, Jr. Approaches to reduce urinary tract injury during management of placenta accreta, increta, and percreta: a systematic review. J Matern Fetal Neonatal Med. 2012; 25(4):329-34.

19. Collins SL, Ashcroft A, Braun T, et al. Proposed for standardized ultrasound descriptions of abnormally invasive placenta (AIP). Ultrasound Obstet Gynecol 2016;47:271-5.

20. Wong HS, Cheung YK, Zuccollo J, Tait J, Pringle KC. Evaluation of sonographic diagnostic criteria for placenta accreta. J Clin Ultrasound. 2008; 36(9):551-9.

21. 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(3):343.

22. Comstock CH, Love JJ Jr, Bronsteen RA, et al. Sonographic detection of placenta accrete in the second and third trimesters of pregnancy. Am J Obstet Gynecol 2004; 190:1135-40.

23. Japaraj RP, Mimin TS, Mukudan K. Antenatal diagnosis of placenta previa accreta in patients with previous cesarean scar. J Obstet Gynaecol Res. 2007; 33(4):431-7.

24. Moodley J, Ngambu NF, Corr P. Imaging techniques to identify morbidly adherent placenta praevia: a prospective study. J Obstet Gynaecol. 2004; 24(7):742-4.

25. ShihJC,PalaciosJaraquemadaJM,SuYN, etal. Roleofthree-dimensionalpowerDopplerin the antenatal diagnosis of placenta accreta: comparison with gray-scale and color Doppler techniques. Ultrasound Obstet Gynecol 2009;33:193-203.

26. Matsuo K, Conturie CL, Lee RH. Snowman sign: a possible predictor of catastrophic abnormal placentation. Eur J Obstet Gynecol Reprod Biol. 2014; 181:341-2.

27. Palacios-Jaraquemada JM, Bruno CH, Martin E. MRI in the diagnosis and surgical management of abnormal placentation. Acta Obstet Gynecol Scand. 2013; 92(4):392-7.

28. Zhang J, Li H, Wang F, Qin H, Qin Q. Prenatal Diagnosis of Abnormal Invasive Placenta by Ultrasound: Measurement of Highest Peak Systolic Velocity of Subplacental Blood Flow. Ultrasound Med Biol. 2018; 44(8):1672-8.

29. 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.e1-7

30. Silver RM, Landon MB, Rouse DJ, Leveno KJ, Spong CY, Thom EA, et al. Maternal morbidity associated with multiple repeat cesarean deliveries. Obstet Gynecol. 2006; 107(6):1226-32.

31. Tikkanen M, Paavonen J, Loukovaara M, Stefanovic V. Antenatal diagnosis of placenta accreta leads to reduced blood loss. Acta Obstet Gynecol Scand. 2011; 90(10):1140-6.

32. D'Antonio F, Iacovella C, Bhide A. Prenatal identification of invasive placentation using ultrasound: systematic review and meta-analysis. Ultrasound Obstet Gynecol. 2013; 42(5):509-17.

33. Chantraine F, Braun T, Gonser M, Henrich W, Tutschek B. Prenatal diagnosis of abnormally invasive placenta reduces maternal peripartum hemorrhage and morbidity. Acta Obstet Gynecol Scand. 2013; 92(4):439-44.

34. Guleria K, Gupta B, Agarwal S, Suneja A, Vaid N, Jain S. Abnormally invasive placenta: changing trends in diagnosis and management. Acta Obstet Gynecol Scand. 2013; 92(4):461-4.

35. Maged AM, Abdelaal H, Salah E, Saad H, Meshaal H, Eldaly A, et al. Prevalence and diagnostic accuracy of Doppler ultrasound of placenta accreta in Egypt. J Matern Fetal Neonatal Med. 2018; 31(7):933-9.

36. Shamshirsaz AA, Fox KA, Salmanian B, Diaz-Arrastia CR, Lee W, Baker BW, et al. Maternal morbidity in patients with morbidly adherent placenta treated with and without a standardized multidisciplinary approach. Am J Obstet Gynecol. 2015; 212(2):218.

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