ORIGINAL ARTICLE

Comparison between a prenatal sonographic scoring system and a clinical grading at delivery for Placenta Accreta Spectrum disorders

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ABSTRACT

Objective: Placenta Accreta Spectrum (PAS) disorders have become a major iatrogenic obstetric complication worldwide. Data on the accuracy of ultrasound examination diagnosis are limited by incomplete confirmation and variability in the description of the different grades of PAS at delivery. The aim of this study was to compare our prenatal routine sonographic screening and diagnostic scoring system with a standardised clinical grading system at birth in patient at risk of PAS

Study design: This is a retrospective cohort study of 607 pregnant patients with at least one prior caesarean delivery between December 2013 – December 2018. All patients were assessed for PAS using our institutional prenatal sonographic scoring system and the corresponding ultrasound findings were compared with those of a standardized clinical intra-operative macroscopic grading system of the degree of accreta placentation at vaginal birth or laparotomy.

Results: PAS was diagnosed clinically at birth in 50 (8.2%) cases, 17 of which were confirmed by histopathology. A low (score $\leq$ 5), medium (score 6-7), high (score $\geq$ 8) probability for PAS was reported in 502, 61 and 44 cases, respectively. The probability score increased significantly (P<0.001) in women $\geq$2 prior cesarean deliveries, with an anterior low-lying/placenta previa, with absent clear space, increased in retroplacental vascularity and with the size and numbers of lacunae. The number of cases classified clinically as grade 1 (non-PAS) and 3 (adherent PAS) was significantly (P<0.001) lower in women with a high probability score whereas the rates of the other grades was significantly (P<0.001) higher. The widest discrepancy between ultrasound probability score and clinical grade was found for grade 2 which, describes a partial placental adherence and grades 4 and 5 which,

refer to placental percreta which describes tissue having invade trough the uterine serosa and beyond.

Conclusions: Both ends of the spectrum of accreta placentation remain difficult to diagnose antenatal and clinically at birth, in particular when no histopathologic confirmation is available. There is a need to develop ultrasound accuracy score systems that can differentiate between the different grades of PAS and which are validated by standardized clinical and pathology protocols.

Keywords: clinical score, placenta accreta, Placenta Accreta Spectrum disorders, prenatal screening, ultrasound, scoring system

Introduction

Placenta Accreta Spectrum (PAS) is a disorder of placentation which include placentas abnormally adherent to the superficial myometrium and/or more deeply implanted into the uterine wall [1]. When undiagnosed prenatally, PAS can be associated with massive obstetric haemorrhage if the operator attempt to deliver the placenta. There is considerable variability in the prevalence of PAS and incidence of placenta previa accreta reported in the international literature due to differences in terminology used to describe the condition perinatally and methodology in the data collection and lack of standardized diagnostic reporting protocol for the confirmation of the diagnosis at birth [2,3]. With the exponential increase in cesarean delivery rates over the last two decades, more than 90% of PAS cases are now found in women with a history of one or more prior cesarean delivery (CD), presenting with an anterior low-lying/placenta previa and the risk increases with the number of prior cesarean section scars [4].

Numerous scoring diagnostic systems have been proposed during the past decade to aid in the prenatal ultrasound diagnosis of PAS [5-15]. An expert review Society for Maternal-Fetal Medicine (SMFM) Placenta Accreta Spectrum Ultrasound Marker Task Force has recently shown that despite a large body of research on various PAS ultrasound markers and their screening performance, inconsistencies in the literature persist. [16]. In 2016, we proposed a probability scoring system based on five sonographic signs and the number of prior CD used in our unit since 2013 [8]. Using the corresponding final score, patients were classified into a low, moderate or high probability for PAS and the corresponding receiver operating (ROC) characteristic curve showed of 0.94 probability for PAS when compared with basic intra-operative findings at the time of the CD [8]. We have also tested our ultrasound

scoring system using targeted protocols for high-risk pregnant women and found that the implementation of this model increases the ultrasound the diagnostic accuracy of PAS from 43.1% to 96.9% when performed by trained operators [17]. This approach was also found to improve overall perinatal outcome in our population [18].

Most scoring systems published so far have use similar ultrasound signs but these scoring systems have not been validated against a clinical standardized intra-operative grading system. In 2015, Collins et al. [19], proposed a clinical grading system for PAS. The aim of the present study was to evaluated the relationship between our prenatal sonographic scoring system for women at risk of PAS with this standardized clinical grading system.

Materials and methods

This is a retrospective study of all pregnant women with at least one prior CD between 1st December 2013 and 31st December 2018. Only women who delivered at our institution with complete clinical record were included in this study. The protocol and a waiver of retrospective consent were approved by our Institutional Review Boards (Yitzhak Shamir Medical Center Reference 12/14).

All patients underwent an antenatal assessment using our scoring system as previously described. The scoring system was made of five parameters (lacuna size, lacuna number, absent clear space, location of the placenta , and lacuna flow with retroplacental hypervascularity) and the number of Prior caesarean delivery this parameters were divided in to three probability scores low > 5 points , moderate 7-8 points and high >8 points, Tovbin et al [8]. The patients were separated into 3 sub-groups based on the probability score used routinely in our institution to tailor the management of individual patient. If the patient required follow-up ultrasound

examinations, the last scan before delivery was used for the final scoring. The placental position was recorded using the American Institute of Ultrasound in Medicine (AIUM) classification i.e. placenta praevia when the placenta lies directly over the internal os and “low lying” when its edge is 0.5-2 cm from the internal os on transvaginal ultrasound (TVS) at any gestational age after 16 weeks [20].

In all cases, the demographic data were collected at the first consultation and all ultrasound images were recorded electronically during the ultrasound examinations. All medical records were reviewed by the same author (MPZ). Surgical reports and detailed records of vaginal birth were obtained from our computerized database. An abnormally adherent placenta was recorded when there was no spontaneous separation and attempt at manual removal of the placenta resulted in heavy bleeding from the placental site during surgery but with no increase in the lower uterine segment vascularity [19]. No histopathology examination could be obtained in those cases. Invasive PAS was recorded when the abnormalities of the uterine wall contour were observed at laparotomy including bluish/purple colouring, distension and hypervascularity of the lower segment [19] without or with tissue seen to be invading through the surface of the uterus with histopathological conformation of grade of invasion i.e. villi invading the uterine wall down to the serosa (increta) or including the uterine serosa and/or beyond the serosa (percreta).

Patient with a low probability for PAS (score < 5 points) were given the choice between a trial of labour after cesarean (TOLAC), if no obstetric contra-indication, and an elective CD. Patients with moderate probability for PAS (score 6-7 points) were informed about the need of possible additional surgical conservative procedures including as B-Lynch compressive suture, intra-uterine balloon tamponade and the need for multiple blood transfusion. Patients with a high

probability for invasive placentation (score ≥ 8 points) were consented for primary cesarean hysterectomy by our surgical multidisciplinary team (MDT).

Statistical analysis

SPSS (SPSS Inc., Chicago, IL, USA, version 25, Chicago, IL, USA) data analysis and statistical software package was used to analyse the data. A standard Kurtosis analysis indicated that the values were normally distributed. Continuous variables presented as mean and standard deviation. Categorical variables are presented as count and percentages. The Pearson $\chi 2$ test, were used to categorical variables. One-way ANOVA was used to test the difference between the three score subgroups. A *P* value of <0.05 was considered statistically significant.

Results

There were 45437 deliveries in our institution during the period of the study including 9389 (20.7%) women delivered by cesarean section. The study group included a cohort of 607 women with a previous CD. PAS was diagnosed clinically at birth in 50 (8.2%). A detailed histopathological examination was performed in all cases requiring a hysterectomy (n=13) or a partial myometrial resection (n=4). The presence of invasive villous tissue within the uterine wall with no invasion of the uterine serosa (increta) was reported in ten (1.6%) cases. In the remaining seven cases, villous tissue was found directly attached to the myometrium with no intermediate decidua and reported as creta or abnormally adherent PAS. In the remaining 33 cases, the diagnosis of PAS was based exclusively on the intra-operative findings and was recorded as abnormally adherent PAS.

The ultrasound scores were as follow: low probability for PAS (score ≤ 5) in 502 cases, medium probability for PAS (score 6-7) in 61 cases and high probability for PAS (score ≥ 8) in 44 cases. The mean (SD) maternal age was 33.7 (4.5), gravity was 3.8 (1.7) and parity was 2.1 (1.3). The mean (SD) number of prior CD was 1.6 (0.8) and 0.5 (0.7) for other prior uterine surgical procedure including curettage, hysteroscopy, myomectomy or difficult manual placental delivery. The mean (SD) gestational age at the final score was 33.4 (4.2) weeks and at delivery was 37.6 (1.6). There was no statistical difference between the score subgroups for the main demographic characteristics except for maternal age which was significantly (P=0.04) lower in the medium score subgroups than in the other subgroups.

Table 1 displays and compares the distribution of the clinical variables and ultrasound signs score results in the different subgroups. The probability sonographic score for PAS increased significantly (P<0.001) in women ≥2 prior CDs, with an anterior low-lying/placenta previa, with absent clear space, increased in retroplacental vascularity and with the size and numbers of lacunae. The main increase between the moderate and high probability subgroup was found for the anterior low-lying/placenta previa, with absent clear space and in increased retroplacental vascularity.

Table 2 presents and compares the distribution of the delivery/intraoperative clinical grade according to the prenatal probability score results. Ten women with a score of > 8 had a complete placental separation at birth. A clinical grade suggesting an abnormally adherent (grades 2 & 3) was recorded in 22 women of which 10 had a prenatal score > 8. Higher grades suggesting an invasive PAS and in particular a placenta percreta were recorded in 22 women including 14 grade 4, four grade 5 and four grade 6, respectively. Six women in this subgroup had a low-risk or moderate

prenatal probability score for PAS. The number of cases classified clinically as grade 1 and 3 was significantly (P<0.001) lower in women with a high probability score whereas the rates of the other grades was significantly (P<0.001) higher. The widest discrepancy between ultrasound probability score and clinical grade was found for grade 2 which describe a partial placental adherence and for grades 4 and 5 which refer to placental tissue having invade trough the uterine serosa and beyond into the bladder. There was no significant difference with advancing gestational age.

The outcomes of score subgroups are presented and compared in Table 1. Fifty (8.2%) women all with a low probability score opted for a TOLAC and 557 (91.8%) underwent a repeat elective CD. At the time of delivery 531 (94.5%) women did not require additional delivery or intraoperative intervention as the placenta separated from the uterine wall after a single dose of oxytocin (10 units IV or IM) at vaginal birth or oxytocin and tranexamic acid (1gr IV) at Cesarean delivery. A conservative management (compressive suture or intrauterine balloon or partial myometrial resection) was possible in 18 cases and 13 cases required a primary hysterectomy. The remaining 19 cases did not require additional intervention.

Discussion

Main findings

This study confirms the data of previous studies showing a good level of agreement between sonographic scoring systems and perinatal outcomes. By contrast, we found a discrepancy between the clinical grading system for vaginal birth and intra-operative findings proposed by Collins et al. [19] and our prenatal probability score. The discrepancy was mainly observed for grades 2 of the clinical classification which correspond to a partially abnormally adherent PAS which is often managed

conservatively and for grades 4 and 5 which describe cases of placenta percreta limited to the serosa of uterine wall or invading the bladder wall. In the absence of histopathologic confirmation of villous tissue invading into the uterine serosa or other part of the lower segment, it is impossible to differentiate between a uterine window secondary to uterine dehiscence which is often reported as placenta percreta at laparotomy and true PAS [21,22]. Recent data have also shown that uterine remodelling following scarification of lower uterine segment after CD lead to abnormalities of the uterine contour on ultrasound such the loss of clear zone, myometrial thinning and placental bulge, independently of accreta placentation [23]. These findings suggest that both ends of the spectrum of accreta placentation remain difficult to diagnose clinically at birth, in particular when no histopathologic confirmation is available.

Strengths and limitations

Our study has a number of strengths compared with other contemporary published studies. First, we have used the same standardised ultrasound imaging protocol for all study participants, limiting an ascertainment bias. Second, our institution serves a non-referred population, making our results more reflective of true risk among a high-risk cohort of women. Last, the overall incidence of cases of PAS in the present study i.e. 50 (8.2%) cases of PAS out of 607 women with a prior CD, is consistent with that reported in large epidemiological studies [24-25] suggesting that the size of cohort is representative of our population low (15-17%) CD rates (Caesarean sections | Health at a Glance 2019 www.oecd-ilibrary.org). The limitation of this study is mainly its retrospective design. All ultrasound examinations in our unit are recorded digitally allowing for re-examination of images if required whereas surgical

reports are hand-written and the description of intra-operative findings may vary between operators. This may be associated with a selection bias due to the knowledge of the final outcome, in particular in cases where no histopathologic confirmation of the diagnosis could be obtained.

Interpretation

Recent epidemiology studies have shown that PAS remains undiagnosed before delivery between half [24,25] and two-thirds of cases [26], in particular in cases of posterior placenta previa [27]. The accuracy of ultrasound in the prenatal diagnosis of PAS depends on the experience of the operator, which has been so far limited by the relative low prevalence of the condition in the general population and the lack of training program similar to those existing for the screening of fetal structural anomalies [28]. We find that our scoring system is efficient to identify patients who need management by a multidisciplinary team (MDT).

Women presenting with a anterior low-lying/placenta previa and history of CD are at the highest risk of PAS and in particular previa PAS [1-4]. Cali et al. [12] have also validated their scoring system using the clinical grading of proposed by Collins et al. [19], however, their cohort included only women presenting with a placenta previa. However, cases of PAS have been reported women with a history of operative hysteroscopy, uterine curettage, endometrial ablation but also presenting with a bicornuate uterus, adenomyosis, submucous fibroids and myotonic dystrophy [4]. In the present study, we have included all women, with a prior cesarean delivery independently of the placental location. Although representing less than < 10% of all women diagnosed with PAS [4,27], women with non-previa PAS, may also require

additional procedure at delivery and management by a MDT and thus will also benefit from ultrasound screening and diagnosis.

Placental ultrasound and histopathologic features associated with PAS are more pronounced in deeply implanted cases suggesting that they are secondary to the effect of the definitive placenta developing close to the radial or arcuate arteries on utero-placental blood flows [29-30]. Overall, the grade of PAS remains difficult to establish when exclusively based on clinical observation. The main impact is on the prevalence of abnormally adherent PAS (placenta creta) and placenta percreta in population studies with proportions ranging between 30 and 82% and 6 and 52%, respectively [2]. Similarly, heterogeneous data were found for studies on the incidence of the different grades of PAS in cohorts of placenta previa accreta with the widest range found for placenta percreta [3]. Furthermore, large dehiscences of the lower segment are common in women with multiple prior CDs and in case of an anterior placenta previa, the placental basal plate may become visible at laparotomy [23]. In most of these cases, the placental tissue abuts the uterine serosa with the villous tissue almost always contained within the scar shell and it is the surgical manipulation and complex dissection that expose the underlying placental tissue often leading to false clinical and histopathologic diagnosis of placenta percreta [31]. Overall, these findings suggest an overdiagnosis of both the creta and percreta grades and support the findings of the present study showing a higher discrepancy between ultrasound data and grade 2,4 and 5 of the clinical classification [19].

The clinical grading proposed by Collins et al. [19] was integrated into the International Federation of Gynaecology and Obstetrics (FIGO) classification [32] which includes both intra-partum/intra-operative clinical descriptive criteria for the diagnosis of PAS and histopathologic confirmation of the PAS grades. This FIGO

classification was also recently used to develop the classification and reporting guidelines for the pathology diagnosis of PAS [33]. Intra-operative and immediate post-operative gross examination provides accurate data on uterine dehiscence, vascular changes and depth of villous invasion in placenta accreta spectrum disorders suggesting that perinatal pathologists should be part of the MDT involved the management PAS disorders [22].

Conclusions

The management strategies for PAS disorders vary depending on the accuracy of prenatal diagnosis, clinical findings at birth and local surgical expertise. The depth and lateral extension of accreta placental tissue is the main determinant of obstetric outcome in women with a PAS disorder and women with deeply implanted PAS with major secondary changes in the utero-placental circulation are at highest risk of intra-operative complications. Both ultrasound scoring and clinical grading systems are limited by the use of different ultrasound signs and lack of standardized description of both the clinical and histopathologic findings at delivery. Standardised classifications were recently proposed for the reporting of PAS and depth of villous implantation at birth [32,33]. Our scoring system could be use as a "first screen" score for women who need a specialist imaging investigations. There is also a need to develop new ultrasound score systems which are validated by standardized clinical and pathology protocols, that can differentiate between superficial and deep villous implantation PAS and between anomalies of the uterine contour due to scarification and the utero-placental vascular changes associated with PAS.

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Table 1: Distribution of the clinical variables and ultrasound signs probability score results and demographic characteristics of the cohort and score subgroups outcomes

Variables	**Low (Score ≤ 5) n (%)**	**Moderate Score 6-7 n (%)**	**High Score > 8 n (%)**	**P**
Prior CDs				
1	291 (58.1%)	23 (37.7%)	15 (34.1%)	
≥2	210 (41.9%)	38 (62.3%)	29 (65.9%)	<0.001
Placental location				
Posterior	126 (25.1%)	2 (3.3%)	0	
Upper segment	350 (69.9%)	42 (68.9%)	6 (13.6%)	
Ant Low-lying/placenta previa	25 (5%)	17 (27.9%)	38 (86.4%)	<0.001
Clear space				
Present	498 (99.4%)	50 (82%)	7 (15.9%)	
Absent	3 (0.6%)	11 (18%)	37 (84.1%)	<0.001
Retroplacental vascularity				
Normal	497 (99.2%)	51 (83.6%)	12 (27.3%)	
Increased	4 (0.8%	10 (16.4%)	32 (72.7%)	<0.001
Lacunae size				
≤2	498 (99.4%)	37 (60.7%)	17 (38.6%)	
>2	3 (0.6%)	24 (39.3%)	27 (61.4%)	<0.001
numbers				
<2	476 (95.1%)	26 (42.6%)	13 (30.3%)	
≥2	25 (5%)	35 (57.4%)	30 (69.8%)	<0.001
Mode of delivery	45 (9%)	5 (8.2%)	0	
SVD (%)				0.116
CD (%)	457 (91%)	56(91.8%)	44 (100%)	
Additional procedures	489 (97.4%)	59 (96.7%)	28 (63.6%)	
None required				
Conservative management	12 (2.4%)	2 (3.3%)	4 (9.1%)	<0.001*
Hysterectomy	1 (0.2%)	0	12 (27.3%)	
No PAS	489 (97.4%)	55 (90.2%)	13 (29.5%)	
PAS Adherent	11 (2.2%)	6 (9.9%)	23 (52.3%)	<0.001
PAS Invasive	2 (0.4%)	0	8 (18.2)	

CD = caesarean delivery; SVD= spontaneous vaginal delivery

*Pearson **Chi-Square Tests**

Table 2: Distribution of the delivery/intraoperative grade according to the prenatal probability score results

Grades	**Score ≤ 5 n (%)**	**Score 6-7 n (%)**	**Score > 8 n (%)**	**P**
Grade 1 (VD or CD) (Complete placental separation)	454 (97.4%)	50 (89.3%)	10 (27.8%)	<0.001
Grade 2 (VD or CD) (Manual removal of placenta required and parts of placenta thought to be abnormally adherent)	1 (0.2%)	4 (7.1%)	7 (19.4%)	<0.001
Grade 3 (VD or CD) (Manual removal of placenta required and the whole placental bed thought to be abnormally adherent)	5 (1.1%)	2 (3.6%)	3 (8.3%)	<0.001
Grade 4 (CD/laparotomy) (Placental tissue appearing to have invaded through the serosa of the uterus but a clear surgical plane can be identified between the bladder and uterus)	5 (1.1%)	0 (0%)	9 (2.5%)	<0.001
Grade 5 (CD/laparotomy) (Placental tissue appearing to have invaded through the serosa of the uterus with no clear surgical plane between the bladder and uterus)	0 (0%)	0 (0%)	4 (11.1%)	<0.001
Grade 6 (CD/laparotomy) (Placental tissue seen to have invaded through the serosa of the uterus and infiltrating the parametrium or any organ other than the urinary bladder)	1 (0.2 %)	0 (0%)	3 (8.3%)	<0.001

CD = caesarean delivery: VD= vaginal delivery