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Is it possible to predict severe postpartum hemorrhage and the need for massive transfusion in placenta previa cases?

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ABSTRACT

Objectives: The aim was to construct a reliable working model for patients with placenta previa (PP) that aids in the prediction of postpartum bleeding potential with data from antenatal imaging studies using both ultrasound (US) and magnetic resonance imaging (MRI).

Material and methods: Forty-three patients with PP were evaluated initially with the US and then by 3-Tesla MRI. The placenta accreata index (PAI) was used during the US evaluation in order to define the risks. Uterine bulging, heterogeneous signal, dark placental bands, focal interruption of myometrium and tenting of bladder wall were regarded as predictive criteria in MRI evaluation. The correlation between the findings from US and MRI studies and subsequent haemorrhage, < 1000 mL, > 1000 mL and severe haemorrhage (> 2000 mL) and massive transfusion [> 5 units of red blood cells (RBC)] were used to build this predictive model. The findings from the imaging studies were also confirmed histopathologically.

Results: In the multivariate analysis of data from patients stratified by bleed size either < 1000 mL or > 1000 mL, none of the MRI and ultrasound findings were found to be predictive. The multivariate analysis was done using the second stratification cut-point of 2000 mL, in patients bleeding > 2000 mL PAI values [OR: 2.3 (1.4–3.8)] and overall MRI reported placenta accreata spectrum [OR: 4.9 (1.8–12.9)] were found to be predictive. While MRI findings were not discriminative between transfusion groups, grade 3 loculation on US examination was found to be predictive for the need of transfusion of > 5 units [OR: 67.5 (8.2–549.4)]. There were no cases needing hysterectomy.

Conclusions: Ultrasound and MRI findings in cases of PP can be helpful in predicting postpartum bleeding.

Keywords: placenta previa; placenta accreata spectrum; postpartum haemorrhage; placenta accreata index

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INTRODUCTION

Placenta previa (PP) is defined as the presence of low-lying placental tissue that covers the internal cervical ostium. The consequences of this condition are increased caesarean section (C-section) rates, and also the potential of early labour and ante-, intra- and post-partum haemorrhage. Large cross-sectional studies and case analyses show that the prevalence of PP is 4/1000 live births [1, 2]. The prevalence before the 20th week gestational age is twice that of term pregnancies which indicates spontaneous resolution during the process of on-going pregnancy. The risk factors for PP include past uterine surgery, history of PP in previous gestations, increased parity and maternal age, infertility treatment, history of uterine evacuation, maternal usage of cocaine, smoking, plural gestations, male foetus and history of uterine artery embolization [3–6].

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The co-existence of the placenta accreata spectrum (PAS) should be considered when PP is diagnosed. PAS includes placenta accreata, increata and percreata, which define invasion of trophoblasts into the myometrium, beyond resulting in the uterine serosa. This condition with its serious maternal and foetal consequences is seen in one in every 500 deliveries and was a rare occurrence in the past [7]. Caesarean section, curettage, and/or myomectomy are present in the history of 80% of patients diagnosed with PAS [8]. This condition should be especially considered when an anteriorly located placenta is found to be covering the hysterotomy incision line. A prospective study by Silver et al. [9], which included 723 patients, reported that the PAS rate increased from 3–67% from the first C-section to the fifth one.

PAS may be predicted with ultrasonography (US) or magnetic resonance imaging (MRI) studies in pregnancies affected by PP or an anteriorly located placenta with a history of previous uterine surgery. Placental lacunae and disruption of the line, which delineates uterine serosa and bladder wall, are the most reliable diagnostic markers [10]. Additionally, loss of the hypoechogenic zone under the placenta, myometrial thinning, an abnormal vascular pattern and exophytic mass protruding from the uterine contour are regarded as other indicative sonographic findings [11, 12]. Turbulent lacunary blood flow, bridge vessels, diffuse or focal intraparenchymal flow, hypervascularity at the bladder-serosa interface, and prominent subplacental venous complexes are valuable indicators in colour Doppler studies [13].

Magnetic resonance imaging can be used when ultrasonographic examination is inconclusive, or if there is suspicion of PAS at the posterior uterine wall, or to determine the extent of the invasion in myometrial or parametrial tissues. However, the benefit of it is not clinically proven to be determinative in the management of patients diagnosed with PAS [14, 15]. Uterine bulging, interruption of the bladder wall, loss of the retroplacental hypointense line on T2W (T2-weighted) images, abnormal vascularization of the placental bed, dark intraplacental bands on T2W imaging, myometrial thinning and focal exophytic mass are amongst the findings on MRI that predict placental invasion. The probability of PAS is believed to increase the higher the number of these findings [16, 17].

In the present study, the aim was to investigate and identify correlations between the antenatal US and MRI findings and subsequent haemorrhage or massive transfusion rates which are causes of major morbidity, secondary to a diagnosis of PP.

MATERIAL AND METHODS

In this study, the data gathered from the medical records of patients diagnosed with total PP in a single centre between 1st January 2015 and 31st December 2022 (8-year data) were analysed retrospectively. All patients were followed up with a diagnosis of probable PP and, at 28 weeks of gestation their total PP diagnoses were confirmed, hence they constituted the study group. Ethical approval to use the hospital medical records was obtained from local authorities (decision number: 11-09.2022). Medical records were accessed between 1st January 2023 and 31st June 2023. As the study was retrospective in design, the ethical committee waived the need to obtain consent from the study participants.

One week before planned operation (n = 36) or immediately before emergency operation (n = 7), all patients with PP diagnosis were evaluated by US using 3.5–5 and 7.5 MHz vaginal probes (Voluson 735 Expert Pro, GE, USA) initially and then subsequently by MRI using a 3-Tesla magnet MRI machine (Achieva/Intera, Release 2.6.1, Series 12.6, Philips Medical Systems, Eindhoven, Netherlands) as per hospital protocol. All variables, including age, gestational age, parity, birth weight, presence of gestational diabetes, operation time, use of blood products, and histopathological confirmation of PAS were also gathered from medical records. All patients were treated with either partial myometrial resection or primary suturing during standard Caesarean sections with Pfannenstiel incision. No hysterectomy operation was performed. All operations were done by the same surgical team who were experienced in high-risk pregnancies. Histopathological diagnosis of PAS was made in the placental tissues when the presence of myometrial fragments beneath trophoblasts was regarded as positive for PAS.

Ultrasound examinations were performed by the same expert, using the 3.5–5 MHz abdominal and 7.5 MHz vaginal probes. Patients were classified using three different set points. The first classification compared patients who bled under 1000 mL with those bleeding > 1000 mL [18]. Similarly, the second classification used 2000 mL as cut off [19], and the third classification compared patients according to their need for transfusion of either less than five units of RBC or those needing 5 units or more [20]. Each group was scored by placenta accreata index (PAI) [21]. The PAI uses parameters, such as the number of caesarean sections, presence of lacunae, anteriorly located placenta, presence of bridging vessels, and myometrial thickness [22]. The PAI index used in the study patients is presented in Table 1.

The MRI protocol began with the acquisition of a three-plane localizer image of the maternal anatomy, sagittal 5 mm T2W single-shot fast spin-echo, and 5 mm T1W images of the entire gravid uterus were performed to evaluate the placental position. A time-of-flight acquisition

was performed in the axial plane to identify placental and maternal vascularity. Each patient group was scored according to the MRI findings, for parameters such as uterine bulging, heterogeneous signal, dark placental bands, focal interruption of myometrium and tenting of the bladder wall. The imaging was done in the supine position and, left lateral decubitus position when the patient could not tolerate being supine.

For the detection of postpartum haemorrhage, the hospital protocols used the signs and symptoms of hypovolemia as described by Bonnar [23]. All cases were delivered by caesarean section. Aspirated blood, used sponges and visual estimation of blood spilled on the floor were used to calculate overall bleeding. The amount of aspirated amniotic fluid during the delivery of the fetus was marked separately in the collector of the aspirator and was not included in the overall bleeding calculation. The decision to give red blood cell transfusion was made if the blood loss was estimated to exceed 1500 mL or haemoglobin concentration was lower than 7 mg/dL.

Table 1. The placenta accreata index [22]

Variable		p value
> 2 caesarean deliveries		3.0
Lacunae[a]	Grade 3	3.5
	Grade 2	1.0
Smallest myometrial thickness[b]	< 1 mm	1.0
	> 1 mm but < 3 mm	0.5
	> 3 mm but < 5 mm	0.25
Anterior placenta previa[c]		1.0
Bridging vessel		0.5

[a]if parameter was not present, then value is 0; [b]measured in the sagittal plane; [c]if any portion of placenta was anterior

Statistical analysis

The collected data were analyzed using Statistical Package for the Social Sciences (SPSS), version 25.0 (IBM Corp., Armonk, NY, USA). The normality of the demographic data was assessed using the Shapiro–Wilk test. Demographic data are summarized as the median and inter-quartile range for non-normally distributed data and as the mean ± standard deviation (SD) for normally distributed data. Student's t-test and the chi-square test were used to compare the means and rates of independent groups, as indicated. A $p < 0.05$ was considered to indicate a significant difference. Logistic regression analysis using the Forward Wald method was used to predict the dichotomous variables, presence and absence of hemorrhage > 1000 mL, > 2000 mL, and need for > 5 units of RBC transfusion separately after inclusion of demographic data, PAI score parameters and MRI parameters, separately.

RESULTS

A total of 43 patients were included. Table 2 shows the comparison of demographic parameters according to study groups. All placentas of study patients were histopathologically examined whereas, 23 out of 43 were diagnosed with PAS. The mean age of the patients with severe hemorrhage was higher than the other groups ($p < 0.001$). The mean parity, duration of operation, presence of gestational diabetes and, histopathologically confirmed PAS rates, were higher in patients in the severe hemorrhage and massive transfusion groups.

Patients were evaluated according to their ultrasound PAI scores in each of the three classification schemes. PAI scores were found to be significantly higher in both those with severe haemorrhage classification groups and also in those who needed more than 5 units of RBC transfusion

Table 2. Demographic data of the study population

Variable	> 1000 mL haemorrhage			> 2000 mL severe haemorrhage			> 5 unit transfusion		
	Yes n = 25	No n = 18	p value	Yes n = 12	No n = 31	p value	Yes n = 11	No n = 32	p value
Age	34.2 ± 6.8	28.1 ± 3.5	0.001	37.1 ± 6.6	29.5 ± 4.9	< 0.001	34.6 ± 9.2	30.6 ± 4.9	0.19
Parity	1.9 ± 0.7	1 ± 0.5	< 0.001	2.3 ± 0.6	1.2 ± 0.6	< 0.001	2.1 ± 0.8	1.3 ± 0.6	0.001
Gestational age (weeks)	34.7 ± 9.7	35.7 ± 1.8	0.14	35.2 ± 0.36	35 ± 2.5	0.76	35.2 ± 0.9	35 ± 2.5	0.78
No previous delivery	6 (24%)	9 (50%)	0.02	2 (16.7 %)	13(41.9%)	< 0.01	1 (9.1%)	14 (43.8%)	< 0.01
Gestational diabetes mellitus	9 (36%)	0	0.004	6 (50%)	3(9.7%)	0.04	6 (54.5%)	3 (9.4%)	0.001
Operation time (minute)	88.6 ± 39.7	36.6 ± 4.8	< 0.001	106.6 ± 42.8	51.4 ± 25.8	< 0.001	119 ± 35	48 ± 21	< 0.001
Histological PAS	20 (80%)	3 (16.7%)	< 0.001	12 (100%)	11(35%)	< 0.001	11 (100%)	12 (37.5%)	< 0.001

PAS — placenta accreata spectrum

(Tab. 3). Other parameters that makeup PAI scoring were also evaluated. Having had two or more Caesarean sections was more common in the group bleeding > 2000 mL compared with the other bleeding groups. However, the number of previous caesarean sections did not differ when patients were stratified by > 5 units transfusion requirement or not. The anterior location of the placenta was more frequent in patients who needed more than 5 units of RBC transfusion. However, this parameter was not different when patients were stratified by haemorrhage classification (Tab. 3).

The patients were also evaluated according to overall MRI reported of PAS (Tab. 4). The finding of dark placental bands on T2W images in MRI was more common in patients who bled more than 1000 mL and in those patients who needed > 5 units of RBC. Every increase in PAI value and every additional PAS sign increased the risk of bleeding > 2000 mL. The MRI findings of uterine bulging, focal interruption of myometrium and tenting of the bladder were significantly more frequent in patients bleeding > 1000 mL, > 2000 mL and those who needed massive transfusion (Tab. 4).

In the multivariate analysis of data from patients in either group of classification according to the cut-off of 1000 mL, none of the MRI or US findings were found to be predictive. In the multivariate analysis done to predict bleeding > 2000 mL, PAI values [OR: 2.3 (1.4–3.8)] and overall MRI reported of PAS [OR: 4.9 (1.8–12.9)] were significant. While MRI findings were not discriminative between transfusion groups, grade 3 loculation on US ultrasound was found to be predictive for the need of transfusion of more than 5 units [OR: 67.5 (8.2–549.4)].

DISCUSSION

Labour can be planned in an elective fashion with a multi-disciplinary approach before any life-threatening bleeding commences, whenever a PAS diagnosis is predicted antenatally. When such an approach is adopted, maternal morbidities, such as major blood loss, need for transfusion, or urological injuries are reported to be significantly decreased [22, 24].

The importance of preparedness when managing life-threatening bleeding in the case of PP cannot be underestimated. Population based studies report that the diagnosis of PP or low-lying placenta can be made in half to two thirds of patients in women with a history

Table 3. Ultrasound finding with respect to haemorrhage outcome

Variable	> 1000 mL haemorrhage			> 2000 mL severe haemorrhage			> 5 units transfusion		
	Yes n = 25	No n = 18	p value	Yes n = 12	No n = 31	p value	Yes n = 11	No n = 32	p value
PAI score	6.6 ± 2.1	3.9 ± 1.4	< 0.001	7.7 ± 1.8	4.6 ± 1.8	< 0.001	8 ± 1.1	4.6 ± 1.9	< 0.001
> 2 C/S	15 (60%)	3 (16.7%)	0.004	9 (75%)	9 (29%)	0.006	7 (63%)	11 (34%)	0.09
Lacunae	11 (44%)	0	0.001	7 (58.3%)	4 (12.9%)	0.002	9 (81.8%)	2 (6.3%)	< 0.001
Myometrial thickness	1.8 ± 1.7	3.7 ± 0.7	< 0.001	1.2 ± 2	3.1 ± 1.2	< 0.001	0.5 ± 0.8	3.3 ± 1.2	< 0.001
Anterior placenta	14 (56%)	5(27.8%)	0.06	8 (66.7%)	11 (35.5%)	0.06	10 (90.9%)	9 (28.1%)	< 0.001
Bridging vessels	16 (64%)	0	< 0.001	9 (75%)	7 (22.6%)	0.001	10 (90.9%)	6 (18.8%)	< 0.001

PAI — placenta accreata index

Table 4. Magnetic resonance imagining finding with respect to clinical outcome

Variable	> 1000 mL hemorrhage			> 2000 mL hemorrhage			> 5 units transfusion		
	Yes n = 25	No n = 18	p value	Yes n = 12	No n = 31	p value	Yes n = 11	No n = 32	p value
Overall MRI reported PAS	21 (84%)	4 (22.2%)	< 0.001	12 (100%)	13 (41.9%)	0.001	11 (100%)	14 (43.8%)	0.001
Uterine bulging	15 (60%)	1 (5.6%)	< 0.001	10 (83.3%)	6 (19.4%)	< 0.001	10 (90.9%)	6 (32.8%)	< 0.001
Heterogeneous signal	8 (32%)	2 (11%)	0.1	5 (41.7%)	5 (16.1%)	0.07	5 (45.5%)	5 (15.6%)	0.05
Dark placental bands on T2W MRI	7 (28%)	1 (5.6%)	0.06	5 (41%)	3 (9.7%)	0.01	4 (36.4%)	4 (12.5%)	0.08
Focal ınterruption of myometrium	1 (5.6%)	18 (72%)	< 0.001	10 (83.3%)	9 (29%)	0.001	10 (90.9%)	3 (9.3%)	< 0.001
Tentıng of bladder	6 (24%)	0	0.002	6 (50%)	0	< 0.001	6 (54.5%)	0	< 0.001

MRI — magnetic resonance imagining; PAS — placenta accreata spectrum; T2W — T2-weighted

of previous uterine surgery. Cali et al performed a study in which they proposed a US-based staging system for PAS disorders, all cases of PP with evidence of increased vascularity in the inferior part of the lower uterine segment, potentially extending into the parametrial region (PAS 3 in the proposed system) were categorized as Stage 6 according to the FIGO postnatal clinical grading system, with good correlation between this ultrasound finding and surgical outcome [25].

Although not routinely used, MRI may help to increase diagnostic accuracy or discriminate suspicious findings obtained from a US study [26]. In the present study, the aim was to augment the efforts of obstetric teams when dealing with life-threatening bleeding events experienced secondary to PP and/or PAS by developing an accurate estimation model of surgical outcome by combining US and MRI findings, together with demographic patient data obtained from medical records. Furthermore, we stratified patients into groups using three classification schemes. The different stratification schemas were used in order to test their predictive competency for catastrophic surgical events. According to our results, the PAI score was capable of predicting excessive haemorrhage (> 1000 mL or > 2000 mL) or the need for transfusion of more than 5 U of RBCs (Tab. 3). This is inconsistent with the study of Rac et al. [27] which found that the smallest anterior myometrial thickness measured in the sagittal plane was the only prognostic criterion to successfully predict massively adherent placentas. There are very few published studies that combine US and MRI findings to predict surgical outcomes in such pregnancies. Only Budorick et al. [28] integrated both modalities. In their study comparison of these two modalities was made without mentioning clinically significant end points, while we analysed their predictive capabilities for different set off points and applied multivariate analyses for each parameter separately. For predicting bleeding of more than 1000 mL neither US nor MRI findings were found to be predictive. However, scoring with both modalities was found to be predictive for a hemorrhage of more than 2000 mL. Interestingly, only grade 3 lacunae detected by the US were found to be successful in predicting the need for transfusion of more than 5 units of RBC. However, to reiterate, each marker of invasion may be correlated with clinically significant bleeding and should not be overlooked.

Study limitations

Our study is limited by its retrospective design, absence of randomization and the small sample size. Moreover, the data about the mortality rate after hospital discharge was not available in our study. This further emphasizes the need for long term follow-up studies.

CONCLUSIONS

Once predicted, knowledge of adverse pregnancy outcomes is always a step forward for clinical teams managing the case. These results show high PAI and overall PAS scores derived from MRI may predict bleeds of > 2000 mL. In addition, if grade 3 loculation is evident on US, it is also highly likely that the patient may need a transfusion of > 5 units. These results should be validated by larger, prospective studies combining the findings of US and MRI in pregnancy.

Article information and declarations

Data availability statement

The hospital record used in study is not assesible.

Ethics statement

The approval of Local Research Ethics Committee (decision dated 02.11.2022 and numbered 11/09).

Author contributions

Concept — E.Ç; design — E.Ç, B.A; data collection or processing — B.A, E.D, Y.A; analysis or interpretation — E.Ç, M.Ç.K; literature search — E.K, E.Ç; writing — E.K, E.Ç. Participation in the study was voluntary and all participants read and approved the informed consent form.

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Conflict of interest

No conflict of interest was declared by the authors.

Supplementary material

None.

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