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Prediction and Clinical Outcomes of Preterm Delivery and Excessive Haemorrhage in Pregnancy with Placenta Previa

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ABSTRACT

Objective: the aim of this study was to identify predictive factors and analyse the clinical outcomes of excessive haemorrhage (EH) and preterm delivery (PT) in pregnancy with placenta previa.

Methods: this is a retrospective study. A PT group and a non-PT (NPT) group were established based on delivery at 36+6 weeks. An EH group and a non-EH (NEH) group were established based on whether the subjects required three or more blood transfusions. We assessed predictions of PT and EH using obstetrical history and prenatal ultrasonographic findings and analysed resultant clinical outcomes.

Results: one hundred forty women were included. The PT group included 63 women and the EH group included 62 women. Antenatal bleeding was the only factor affecting PT. Complete placenta previa, multiple lacuna spaces, and shorter cervical lengths were significantly related to EH. The frequency of additional procedures for bleeding control and hysterectomy was not different between the PT and NPT groups. Gestational age at delivery was not significantly different between the EH and NEH groups.

Conclusion: the predictive factors affecting PT and EH and their clinical outcome in placenta previa are different. Analysing and managing individual risks for each patient will be helpful in pregnancy with placenta previa.

Keywords: abnormally invasive placenta; placenta; postpartum haemorrhage; preterm birth; high-risk pregnancy.

SOMMARIO

Obiettivo: lo scopo di questo studio era quello di identificare i fattori predittivi e di analizzare l'esito clinico dell'emorragia eccessiva (EH) e del parto pretermine (PT) in gravidanza con placenta previa.

Metodi: questo è uno studio retrospettivo. PT è stato classificato in un gruppo PT e un gruppo non PT (NPT) basato su 36 + 6 settimane. EH è stata classificata in un gruppo EH e in un gruppo non-EH (NEH) basata su tre o più trasfusioni di sangue. Abbiamo valutato la predizione di PT ed EH utilizzando la storia ostetrica e i risultati ecografici prenatali e il loro esito clinico.

Risultati: il numero di donne incluse era 140. Il gruppo PT comprende 63 donne e il gruppo EH comprendeva 62 donne. Il sanguinamento prenatale era l'unico fattore che influenzava il PT. Completa placenta previa, multiple lacune e lunghezze cervicali più corte erano significativamente correlate all'EH. La frequenza delle procedure aggiuntive per il controllo del sanguinamento e l'isterectomia non era diversa tra i gruppi PT e NPT. L'età gestazionale al parto non era significativamente diversa tra i gruppi EH e NEH.

Conclusione: i fattori predittivi che influenzano il PT e l'EH e il loro esito clinico in placenta previa sono diversi. L'analisi e la gestione dei rischi individuali per ciascun paziente saranno utili in gravidanza con placenta previa.

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INTRODUCTION

The prevalence of placenta previa has recently been reported to be approximately 5 per 1,000 pregnancies[1]. Placenta previa may cause peripartum haemorrhage and increase maternal and foetal morbidity. Haemorrhage in placenta previa is divided into antepartum haemorrhage, which suddenly occurs during pregnancy, and postpartum haemorrhage, which occurs after separation of the placenta. The aetiology of antepartum haemorrhage involves a placenta implanted in the lower uterine segment, which has a thin myometrium. The placenta is easily separated from the uterus even in weak uterine contractions, and bleeding occurs. The degree of bleeding varies. However, predicting the timing and amount of antepartum haemorrhage in placenta previa is difficult. On the other hand, postpartum haemorrhage is caused by adhesions between the placenta and uterine myometrium. Histologically, faulty formation of Nitabuch's layer between the placenta and uterine myometrium is the cause of placental adhesion. Massive bleeding may occur after placental separation depending on the degree of adhesion. A hysterectomy may be required if the adhesion is severe. Placental adhesions can be confirmed by histological examination of the extracted uterus. Many studies have predicted placental adhesion in pregnancy with placenta previa. However, in actual placenta previa, only 2.7% of cases require hysterectomy[2]. Most pregnancies with placenta previa that do not require hysterectomy also show increased maternal and foetal morbidity. Maternal morbidity is associated with excessive bleeding before and after delivery, and foetal morbidity is associated with preterm birth. Therefore, it is important to study the prenatal prediction and clinical outcome of these two problems.

The primary purpose of this study was to identify the predictive factors affecting preterm delivery and peripartum haemorrhage in placenta previa pregnancies. In addition, we aimed to analyse clinical outcomes according to preterm birth and peripartum haemorrhage.

MATERIALS AND METHODS

This retrospective study of women diagnosed with placenta previa at Haeundae Paik Hospital, Inje University, was conducted from March 2010 to October 2017. Medical histories and ultrasound findings of women who were diagnosed with placenta previa after 20 gestational weeks and gave a birth in this hospital between 23 and 40 gestational weeks were reviewed. Pregnancies with complete placenta previa and partial placenta previa were included. The following cases were excluded: multiple pregnancies, cases diagnosed with placenta previa that delivered at another hospital, cases diagnosed with placenta previa that later underwent vaginal delivery because the placenta moved up to the uterine fundus, cases of preterm delivery due to causes other than placenta previa, cases with uterine myoma or a history of prior preterm births that may affect preterm labour or haemorrhage, cases in which ultrasound pictures were not stored, cases of incompetence of the internal os of the cervix diagnosed in a previous pregnancy, cases of preterm labour, preterm premature membrane rupture, or incompetence of internal os of the cervix in the present pregnancy and cases of transfusion caused by the placenta for reasons other than placenta previa (for example, aplastic anaemia or idiopathic thrombocytopenic purpura).

The following criteria were used to analyse preterm delivery and excessive haemorrhage in the included women. Preterm delivery was categorized based on 36 weeks of gestation. The preterm delivery (PT) group included women who delivered on or before 36+6 weeks of gestation, and the non-preterm delivery (NPT) group included women who delivered on or after 37+0 weeks of gestation. The amount of blood transfused before and after delivery was used to quantitatively determine the amount of peripartum haemorrhage. The cases in which three or more transfusions were needed were assigned to the excessive haemorrhage (EH) group. The cases in which zero to two transfusions were needed were assigned to the non-excessive haemorrhage (NEH) group.

Predictors and clinical outcomes affecting preterm delivery and excessive bleeding were analysed between the PT and NPT groups and between the EH and NEH groups. We investigated maternal age, parity, previous abortion history, and caesarean section history as predictors of preterm birth and excessive haemorrhage in pregnancy with placenta previa. The presence of antenatal haemorrhage was also assessed. A blinded review of antenatal ultrasound findings was carried out without any knowledge of medical history. All ultrasound examinations had been performed using a C1-5-D transabdominal probe (4.0-9.0 MHz) and an RCI5-9-F transvaginal probe (2.0-5.0 MHz; Voluson E8; GE healthcare, Kretztechnik, Zipf, Austria). The pictures stored in

the PACS (Picture Archiving and Communication System) were reviewed. Placental location (anterior placenta versus posterior placenta) and type (complete previa versus partial previa) were analysed. Four ultrasound findings for predicting adherent placenta were reviewed: myometrial thinning, subplacental hypervascularity, loss of retroplacental clear zone, and multiple lacuna spaces. Myometrial thinning was indicated when the thickness of the myometrium was less than 1 mm. Subplacental hypervascularity was defined when the blood vessels surrounding the placenta were enlarged and turbulent flow was observed in the blood vessels. Loss of the retroplacental clear zone was identified when the decidua basalis was not clearly visible. Multiple lacunar spaces were defined as 4 or more lacunar spaces within the placenta. After placenta previa was diagnosed, the length of cervix was measured at every follow-up examination. The cervical length measured by transvaginal ultrasound at the last prenatal examination before delivery was used in this study.

Clinical outcomes of preterm delivery and excessive haemorrhage were analysed in terms of gestational age at delivery, birth weight, total amount of peripartum transfusion, emergency operation, operation duration, additional procedures for bleeding control (intrauterine balloon tamponade, bilateral uterine artery ligation, or uterine artery embolization), and hysterectomy.

In lieu of a formal ethics committee, Helsinki declaration principles were followed.

STATISTICAL ANALYSIS

The data are presented as frequency with percentage for categorical variables and mean ± standard deviation (SD) if the data were normally distributed or median with range for other continuous variables. Differences in predictors and clinical outcomes between the PT and NPT groups and between the EH and NEH groups were compared with chi-square test or Fisher's exact test for categorical variables and independent test or Mann-Whitney's U test for continuous variables as appropriate. We used Shapiro-Wilk's test to determine whether a distribution was normal. Univariate and multivariate analyses using logistic regression were performed to identify predictive factors that were independently related to preterm delivery and excessive peripartum haemorrhage. The multivariate model was created using a background elimination method, and the probability was set at 0.05 for removal. Odd ratios (OR) and 95% confidence intervals (CI) were calculated for preterm delivery and excessive haemorrhage.

All statistical analyses were carried out using SPSS 24.0, and P less than 0.05 was considered statistically significant.

RESULTS

During the study period, 26,300 women delivered; 167 of these women were diagnosed with placenta previa at this institute. Of these 167 women, 27 were excluded for fulfilling the exclusion criteria. Finally, 140 women with placenta previa were included in the study. The number of cases of complete placenta previa was 67, and the number of preterm delivery cases before 36+6 gestational weeks was 63. There were 62 women who received more than three packs of blood transfusions before and after delivery. There were 14 women who underwent hysterectomy due to uncontrolled bleeding during delivery, and these women were confirmed to have placental adhesion with uterine biopsy. The basic characteristics of the women included in the study are shown in **Table 1**.

Comparisons between the PT and NPT groups showed that antenatal haemorrhage, complete placenta previa and loss of retroplacental clear space were risk factors affecting preterm delivery before 36+6 gestational weeks (**Table 2**). The multivariate analysis (**Table 3**) showed that only antepartum haemorrhage was significantly related to preterm delivery (odds ratio, OR 77.72, 95% confidence interval, CI 25.12-240.50, P<0.001). However, this result should be interpreted with caution since only 5 patients experienced preterm delivery among the patients without antepartum haemorrhage. The percentage of preterm delivery cases was significantly different between the groups regarding antepartum haemorrhage (chi-square test, P<0.001).

The results of analysis of factors affecting peripartum transfusion are presented at **Table 4**. In multivariate analysis of these factors, complete previa was a significant factor affecting peripartum transfusion (OR 3.22, 95% CI 1.41-7.33, P=0.005). Multiple lacuna spaces >4 was also found to be a significant factor affecting transfusion (OR 9.81, 95% CI 2.92-32.94, P<0.001). In addition, shorter cervical length at the third trimester was significantly related to increased transfusion (OR 0.55, 95% CI 0.31-0.97, P=0.033) (**Table 5**).

Table 6 shows the clinical outcomes according

Table 1.
Patients' baseline characteristics.

Variable	
Maternal age median (min-max)	33.6 (22-44)
Multigravida	
multi	65 (46.4)
primi	75 (53.6)
Previous curettage	
yes	58 (41.4)
no	82 (58.6)
Previous cesarean	
yes	27 (19.3)
no	113 (80.7)
Complete previa	
complete	67 (47.8)
partial	73 (52.2)
Anterior placenta location	
anterior	43 (30.7)
posterior	97 (69.3)
Ultrasound findings Thin myometrium < 1 cm	
yes	32 (22.9)
no	108 (77.1)
Hypervascularity around placenta	
yes	57 (40.7)
no	83 (59.3)
Loss of retroplacental clear space	
yes	55 (39.3)
no	85 (60.7)
Multiple lacuna space	
≥4	32 (22.9)
0-3	108 (77.1)
Cervical length at 3rd trimester mean±SD	3.45±0.76

Values are frequency with percentage in parentheses for categorical data and mean ± standard deviation or median with range in parentheses for continuous data.
1 P was derived from chi-square test.
2 P was derived from independent t-test.
3 P was derived from Mann-Whitney's U test.

to preterm delivery and excessive haemorrhage. The PT group had earlier delivery and more frequent emergency surgery than the NPT group. However, the amount of total transfusion, operation time, and the frequency of additional procedures for bleeding control and hysterectomy were not different from the NPT group. In terms of excessive bleeding, there was no significant difference in the number of preterm deliveries between the EH and NEH groups. The EH group had more emergency surgery, longer operation times, and higher frequency of additional procedures for haemostasis and hysterectomy than the NEH group.

DISCUSSION

The maternal mortality rate is declining with improved management during pregnancy. Obstetric haemorrhage is one of the major causes of maternal mortality. Placenta previa-related bleeding is an important component of obstetric haemorrhage. In pregnancy with placenta previa, haemorrhage occurs mainly after placental separation. Histologically, the placenta adheres to the myometrium as a partial loss of decidua basal membrane or abnormal development of the fibrin layer (Nitabuch's layer). If the adhesion is severe, the risk of bleeding after placental separation increases. Previous caesarean section or previous curettage may interfere with Nitabuch's layer formation[3]. Recently, many studies have been conducted to predict placental adhesion using antenatal ultrasound findings. These ultrasound findings referred to the loss of retroplacental clear space, myometrial thinning, multiple lacuna spaces, and hypervascularity around the placenta. Loss of retroplacental clear space, irregular uterine-bladder interface, and myometrial thinning suggest that the placenta adheres to or invades the myometrium. Lacuna spaces are vascular lakes of various sizes and shapes seen within the placental parenchyma. Their exact mechanism of development is unknown, but a large amount of blood flow and high flow rate of adherent placenta and inappropriate placental implantation are known to cause mechanical disruption of the placenta[4]. Yang et al. classified placental lacuna spaces into four grades according to their number and shape. They reported that the presence of grade 2 lacuna spaces (four to six irregularly shaped lacuna spaces) was strongly associated with placenta adhesion[5]. Rac et al. reported a scoring system, termed the "Placenta Accreta Index", that predicted the degree of placental adhesion with these ultrasonographic findings and previous caesarean histories[6]. This 9-point scale provided a probability of invasion that ranged from 2% to 96%. They carried out other studies to predict placental adhesion using ultrasound findings in early pregnancy and reported that smallest myometrial thickness in the first trimester suggested placenta adhesion[7]. Magnetic resonance imaging (MRI) may also be used to more accurately predict placental adhesion[8,9]. However, in most studies, the ultimate goal of prediction using ultrasound findings is placental adhesion (histologically) and hysterectomy (clinically). Even if haemorrhage does not warrant hysterectomy, the causal factors for excessive haemorrhage requiring a

Table 2.
Predictive factor analysis affecting preterm delivery.

Variable	Preterm delivery			Univariate logistic regression analysis		
	<37 weeks (n=63)	≥37 weeks (n=77)	P	OR	95% CI	P
Antenatal bleeding						
yes	58 (92.1)	10 (13.0)	.0001	77.72*	(25.12-240.50)	.000
no	5 (7.9)	67 (87.0)		1.00		
Maternal age						
median (min-max)	33 (26-44)	33 (22-42)	.7813	1.04	(0.95-1.14)	.391
Multigravida						
multi	33 (52.4)	32 (41.6)	.2011	1.55	(0.79-3.03)	.202
primi	30 (47.6)	45 (58.4)		1.00		
Previous curettage						
yes	29 (46.0)	29 (37.7)	.3171	1.41	(0.72-2.78)	.318
no	34 (54.0)	48 (62.3)		1.00		
Previous cesarean						
yes	14 (22.2)	13 (16.9)	.4261	1.41	(0.61-3.26)	.427
no	49 (77.8)	64 (83.1)		1.00		
Complete previa						
complete	37 (58.7)	30 (39.0)	.0201	2.23	(1.13-4.40)	.021
partial	26 (41.3)	47 (61.0)		1.00		
Anterior placenta location						
anterior	20 (31.7)	23 (29.9)	.8111	1.09	(0.53-2.25)	.811
posterior	43 (68.3)	54 (70.1)		1.00		
Ultrasound findings Thin myometrium <1 cm						
yes	19 (30.2)	13 (16.9)	.0631	2.13	(0.95-4.75)	.066
no	44 (69.8)	64 (83.1)		1.00		
Hypervascularity around placenta						
yes	26 (41.3)	31 (40.3)	.9041	1.04	(0.53-2.05)	.904
no	37 (58.7)	46 (59.7)		1.00		
Loss of retroplacental clear space						
yes	32 (50.8)	23 (29.9)	.0121	2.42	(1.21-4.85)	.012
no	31 (49.2)	54 (70.1)		1.00		
Multiple lacuna space						
≥4	16 (25.4)	16 (20.8)	.5171	1.30	(0.59-2.86)	.518
0-2	47 (74.6)	61 (79.2)		1.00		
Cervical length at 3rd trimester						
mean±SD	3.40±0.81	3.50±0.72	.4052	0.83	(0.53-1.29)	.403

Values are frequency with percentage in parentheses for categorical data and mean ± standard deviation or median with range in parentheses for continuous data.
1 P was derived from chi-square test.
2 P was derived from independent t-test.
3 P was derived from Mann-Whitney's U test.
Shapiro-Wilk's test was employed for test of normality assumption.
**Among patients without antenatal bleeding, preterm delivery was observed in only 5 patients. Therefore, the result should be interpreted with caution due to small sample size.*

Table 3.
Risk factor analysis affecting preterm delivery (via multivariate logistic regression).

Variable	Multivariate logistic regression analysis		
	OR	95% CI	P
Antenatal bleeding			
yes	77.72	(25.12-240.50)	.000
no	1.00		

**Among patients without antenatal bleeding, only 5 patients were observed preterm delivery. Therefore, the result should be interpreted with caution due to small sample size.*
The multivariate model was created using a backward elimination method, and the probability was set at 0.05 for removal.

large amount of blood transfusion or additional procedures, such as intrauterine tamponade, uterine artery embolization and bilateral uterine artery ligation, must be investigated. Gibbins et al. reported that the risk of haemorrhagic morbidity was higher in women with placenta previa than in women with caesarean section due to other causes in an analysis excluding patients who underwent hysterectomy[10]. One of the purposes of this study was to analyse predictive factors and clinical outcomes in terms of excessive haemorrhage regardless of hysterectomy.

Excessive haemorrhage is the most problematic aspect from the mother's position, but from the foetus' position, preterm delivery due to bleeding is an important factor that affects the baby's prognosis. Another purpose of this study was to analyse predictive factors and clinical outcomes in terms of preterm delivery. Many studies have explored factors that may cause preterm delivery in the context of placenta previa. Sekiguchi et al. reported that anteriorly located placenta previa and complete placenta previa were important factors in preterm delivery[11]. Fishman et al. reported that the presence of antenatal bleeding is a major causal factor for preterm delivery in pregnancy with placenta previa[12]. According to Lam's study, the prevalence of preterm delivery increases when antenatal bleeding occurs before 29 weeks, occurs more than 3 times, or if it was a complete placenta previa[13]. Another study reported that the risk of preterm delivery in a placenta previa pregnancy increases when second trimester haemorrhage is associated with uterine contractions[14]. However, in these studies, they only reported the association between antenatal bleeding and preterm delivery in placenta previa. Antenatal ultrasound findings regarding adherent placenta and cervical length were not considered.

Although it is well known that antenatal ultrasound findings suggesting placental adhesion may predict hysterectomy, no study has yet been conducted on whether these ultrasound findings can predict preterm delivery in placenta previa. One study investigated whether antenatal haemorrhage can be predicted by antenatal ultrasound findings suggesting placenta adherent. Hasegawa et al. reported that antenatal haemorrhage cannot be predicted with antenatal ultrasound findings[15]. Recent studies have suggested that antenatal bleeding can be predicted by a short cervical length during pregnancy with placenta previa[3,16,17].

These results suggest that the mechanisms of antenatal haemorrhage and postpartum haemorrhage are different in pregnancy with placenta previa. In other words, haemorrhage due to placental adhesion occurs after separation of the placenta, causing postnatal haemorrhage, whereas antenatal haemorrhage is caused by poor placental implantation in the lower uterine segment, where few uterine muscles exist. The placenta is easily detached from the decidua basalis even during weak uterine contractions, thus inciting antenatal haemorrhage. When fine bleeding occurs, the blood causes further placental detachment[3]. No studies have analysed all possible predictive factors and clinical outcomes of both preterm delivery and excessive haemorrhage in the same patient group. Therefore, the aim of this study was to investigate the predictive factors and clinical outcomes of preterm delivery and excessive haemorrhage in pregnant women with placenta previa.

In this study, transfusion of three packs of red blood cells or more was used to quantitatively measure peripartum haemorrhage. Preterm delivery was defined as delivery before 37+0 gestational weeks. The multivariate analysis showed that antenatal haemorrhage was the only factor affecting preterm delivery in placenta previa. Complete placenta previa, multiple lacuna

Table 4.
Risk factor analysis affecting amount of peripartum transfusion .

Variable	Peripartum transfusion			Univariate logistic regression analysis		
	≥3	0-2	P	OR	95% CI	P
Antenatal bleeding						
yes	36 (58.1)	32 (41.0)	.0451	1.99	(1.01-3.92)	.046
no	26 (41.9)	46 (59.0)		1.00		
Maternal age						
median (min-max)	34.50±3.99	32.90±3.34	.0112	1.13	(1.03-1.25)	.013
Multigravida						
multi	32 (51.6)	33 (42.3)	.2731	1.45	(0.74-2.84)	.274
primi	30 (48.4)	45 (57.7)		1.00		
Previous curettage						
yes	30 (48.4)	28 (35.9)	.1361	1.67	(0.85-3.30)	.137
no	32 (51.6)	50 (64.1)		1.00		
Previous cesarean						
yes	19 (30.6)	8 (10.3)	.0021	3.87	(1.56-9.60)	.004
no	43 (69.4)	70 (89.7)		1.00		
Complete previa						
complete	44 (71.0)	23 (29.5)	.0001	5.85	(2.81-12.17)	.000
partial	18 (29.0)	55 (70.5)		1.00		
Anterior placenta location						
anterior	27 (43.5)	16 (20.5)	.0031	2.99	(1.42-6.29)	.004
posterior	35 (56.5)	62 (79.5)		1.00		
Ultrasound findings						
Thin myometrium <1 cm						
yes	21 (33.9)	11 (14.1)	.0061	3.12	(1.37-7.13)	.007
no	41 (66.1)	67 (85.9)		1.00		
Hypervascularity around placenta						
yes	32 (51.6)	25 (32.1)	.0191	2.26	(1.14-4.50)	.020
no	30 (48.4)	53 (67.9)		1.00		
Loss of retroplacental clear space						
yes	33 (53.2)	22 (28.2)	.0031	2.90	(1.44-5.84)	.003
no	29 (46.8)	56 (71.8)		1.00		
Multiple lacuna space						
≥4	28 (45.2)	4 (5.1)	.0001	15.24	(4.95-46.86)	.000
0-2	34 (54.8)	74 (94.9)		1.00		
Cervical length at 3rd trimester						
mean±SD	3.30±0.69	3.57±0.80	.0382	0.62	(0.39-0.98)	.041

Values are frequency with percentage in parentheses for categorical data and mean ± standard deviation or median with range in parentheses for continuous data.
1 P was derived from chi-square test.
2 P was derived from independent t-test.
3 P was derived from Mann-Whitney's U test.
Shapiro-Wilk's test was employed for test of normality assumption.

Table 5.
Risk factor analysis affecting the amount of peripartum transfusion (via multivariate logistic regression).

Variable	Multivariate logistic regression analysis		
	OR	95% CI	P
Complete previa complete partial	 3.22 1.00	 (1.41-7.33)	 .005
Multiple lacuna space ≥4 0-3	 9.81 1.00	 (2.92-32.94)	 .000
Cervical length at 3rd trimester (unit:cm)	 0.55	 (0.31-0.95)	 .033

The multivariate model was created using a backward elimination method, and the probability was set at 0.05 for removal.

spaces, and short cervical length during the third trimester affected excessive haemorrhage. The risk factors for preterm labour and excessive bleeding differed, which was anticipated. However, cervical length was different than expected. From the perspective of preterm delivery, average cervical length was slightly shorter in the PT group than in the NPT group, but this difference was not statistically significant. Other results might appear with a greater number of cases. Our analysis based on the amount of transfusion showed significantly shorter cervical lengths in the EH group. Previous studies on cervical length have analysed antenatal haemorrhage, not preterm delivery, and were mostly retrospective studies. One report indicated that antenatal haemorrhage cannot be predicted by a short cervical length[15]. The relationship between short cervical length and preterm delivery or excessive haemorrhage in placenta previa seems to require further investigation.

In the comparison of clinical outcomes between the PT and NPT groups, the number of emergency operations due to uncontrolled bleeding was higher and the amount of peripartum transfusion was greater in the PT group. The frequency of additional procedures, such as intrauterine tamponade and hysterectomy due to uncontrolled bleeding, did not increase in the PT group, and there was no difference between the two groups in terms of operation duration. Although there was a statistically significant increase in the amount of transfusion in the PT group, this difference does not seem to be clinically meaningful when the difference in the amount of transfused blood is considered (a mean of 3 packs of red blood cells in the PT group versus a mean of 2 packs of red blood cells in the NPT group). In the comparison between the EH and NEH groups, the operative time was longer and the frequency of additional procedures and hysterectomy to control haemorrhage was significantly increased in the EH group. However, no significant difference in gestational age at delivery was found in the EH group (**Table 6**). In short, no correlation was identified between preterm birth and excessive haemorrhage in pregnancy with placenta previa. The number of patients who underwent hysterectomy due to severe uterine adherence was fourteen in this study. Among these patients, only five patients experienced preterm delivery. The mean gestational age at delivery of patients who underwent hysterectomy was 33.5 weeks, which was earlier than the 35.3 gestational weeks at delivery of patients who did not undergo hysterectomy; however, this difference was not statistically significant (P=0.072).

The limitations of this study are that it is a retrospective study and that it was conducted at a single centre. However, this study was the first to analyse the predictive factors and clinical outcomes of excessive haemorrhage and preterm delivery, which are important prognostic factors for a mother and foetus, who represent the same patient.

In conclusion, preterm delivery and excessive haemorrhage in pregnancy with placenta previa had different predictive factors and clinical outcomes. No correlation was found between preterm delivery and excessive haemorrhage in pregnancy with placenta previa. Antenatal

Table 6.
Comparison of maternal and neonatal outcomes according to preterm delivery.

Variable	Preterm delivery			Excessive bleeding		
	<37 weeks	≥37 weeks	p	TF >3	TF 0-2	p
Gestational age at delivery median (min-max)	34(21-36)	37(37-40)	.0004	36(21-36)	37(27-39)	0.074
Blood transfusion median (min-max)	3(0-21)	2(0-14)	.0064	5(3-21)	0(0-2)	0.004
Emergency operation emergency elective	59(93.7) 4(6.3)	9(11.7) 68(88.3)	.0001	28(61.3) 24(38.7)	30(38.5) 48(61.5)	0.0071
Operation duration median (min-max)	75(40-180)	65(35-170)	.0734	90(50-180)	55(35-105)	0.0004
Additional procedures* ≥1 0	15(23.8) 48(76.2)	14(18.2) 63(81.8)	.4141	25(40.3) 37(59.7)	4(5.1) 74(94.9)	0.0001
Hysterectomy yes no	7(11.1) 56(88.9)	7(9.1) 70(90.9)	.6921	14(22.6) 48(77.4)	0(0.00) 78(100.0)	0.0001
Birth weight mean±SD	2056.1 ±718.1	3011.8 ±320.6	.0003	2680 ±	2800 ±	0.2154
Apgar Score 1 min median (min-max)	7(2-9)	9(2-10)	.0004	8(2-10)	9(2-10)	0.0254
Apgar Score 5 min median (min-max)	9(5-10)	10(7-10)	.0004	9(6-10)	10(5-10)	0.0324

Values are frequency with percentage in parentheses for categorical data and mean ± standard deviation or median with range in parentheses for continuous data.
** intrauterine tamponade or uterine artery ligation or uterine artery embolization.*
1 p was derived from chi-square test.
2 p was derived from Fisher's exact test.
3 p was derived from independent t-test.
4 p was derived from Mann-Whitney's U test.
Shapiro-Wilk's test was employed for test of normality assumption.

bleeding affected preterm delivery and complete placenta previa, previous curettage, multiple lacuna spaces in ultrasound examination, and short cervical length affected excessive bleeding in pregnancy with placenta previa. Although there was more bleeding in patients who underwent preterm delivery, this bleeding was not clinically excessive.

Analysing and managing individual risks for each patient will help improve the prognosis of both the mother and the foetus in a pregnancy with placenta previa.

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REFERENCES

1) Fan D, Wu S, Liu L, Xia Q, Wang W, Guo X, et al. **Prevalence of antepartum hemorrhage in women with placenta previa: a systematic review and meta-analysis.** Scientific reports. 2017;7:40320.
2) Lyu B, Chen M, Liu XX. **Risk factors of peripartum hysterectomy in placenta previa: a retrospective study of 3 840 cases.** Zhonghua fu chan ke za zhi. 2016;51(7):498-502.
3) Hasegawa J, Nakamura M, Hamada S, Matsuoka R, Ichizuka K, Sekizawa A, et al. **Prediction of hemorrhage in placenta previa.** Taiwanese journal of obstetrics & gynecology. 2012;51(1):3-6.
4) Shetty MK, Dryden DK. **Morbidly Adherent Placenta: Ultrasound Assessment and Supplemental Role of Magnetic Resonance Imaging.** Seminars in ultrasound, CT, and MR. 2015;36(4):324-31.
5) Yang JI, Lim YK, Kim HS, Chang KH, Lee JP, Ryu HS. **Sonographic findings of placental lacunae and the prediction of adherent placenta in women with placenta previa totalis and prior Cesarean section.** Ultrasound in obstetrics & gynecology : the official journal of the International Society of Ultrasound in Obstetrics and Gynecology. 2006;28(2):178-82.
6) Rac MW, Dashe JS, Wells CE, Moschos E, McIntire DD, Twickler DM. **Ultrasound predictors of placental invasion: the Placenta Accreta Index.** American journal of obstetrics and gynecology. 2015;212(3):343.e1-7.
7) Rac MW, Moschos E, Wells CE, McIntire DD, Dashe JS, Twickler DM. **Sonographic Findings of Morbidly Adherent Placenta in the First Trimester.** Journal of ultrasound in medicine : official journal of the American Institute of Ultrasound in Medicine. 2016;35(2):263-9.
8) Tanimura K, Yamasaki Y, Ebina Y, Deguchi M, Ueno Y, Kitajima K, et al. **Prediction of adherent placenta in pregnancy with placenta previa using ultrasonography and magnetic resonance imaging.** European journal of obstetrics, gynecology, and reproductive biology. 2015;187:41-4.
9) Rahaim NS, Whitby EH. **The MRI features of placental adhesion disorder and their diagnostic significance: systematic review.** Clinical radiology. 2015;70(9):917-25.
10) Gibbins KJ, Einerson BD, Varner MW, Silver RM. **Placenta previa and maternal hemorrhagic morbidity.** The journal of maternal-fetal & neonatal medicine : the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstet. 2018;31(4):494-9.
11) Sekiguchi A, Nakai A, Kawabata I, Hayashi M, Takeshita T. **Type and location of placenta previa affect preterm delivery risk related to antepartum hemorrhage.** International journal of medical sciences. 2013;10(12):1683-8.
12) Fishman SG, Chasen ST, Maheshwari B. **Risk factors for preterm delivery with placenta previa.** Journal of perinatal medicine. 2011;40(1):39-42.
13) Pivano A, Alessandrini M, Desbriere R, Agostini A, Opinel P, d'Ercole C, et al. **A score to predict the risk of emergency cesareandelivery in women with antepartum bleeding and placenta praevia.** European journal of obstetrics, gynecology, and reproductive biology. 2015;195:173-6.
14) Lam CM, Wong SF. **Risk factors for preterm delivery in women with placenta praevia and antepartum hemorrhage: retrospective study.** Hong Kong medical journal = Xianggang yi xue za zhi. 2002;8(3):163-6.
15) Hasegawa J, Higashi M, Takahashi S, Mimura T, Nakamura M, Matsuoka R, et al. **Can ultrasonography of the placenta previa predict antenatal bleeding?** Journal of clinical ultrasound : JCU. 2011;39(8):458-62.
16) Shin JE, Shin JC, Lee Y, Kim SJ. **Serial Change in Cervical Length for the Prediction of Emergency Cesarean Section in Placenta Previa.** PloS one. 2016;11(2):e0149036.
17) Zaitoun MM, El Behery MM, Abd El Hameed AA, Soliman BS. **Does cervical length and the lower placental edge thickness measurement correlates with clinical outcome in cases of complete placenta previa?** Archives of gynecology and obstetrics. 2011;284(4):867-73.