CEOG Clinical and Experimental Obstetrics & Gynecology

Original Research

Does previous cesarean section per se, especially its number, increase the risk of allogeneic blood transfusion at cesarean section for placenta previa?

H. Takahashi, Y. Baba, M. Ogoyama, H. Suzuki, A. Ohkuchi, R. Usui, S. Matsubara

[1]*Department of Obstetrics and Gynecology, Jichi Medical University, Tochigi (Japan)*

Summary

Objective: At cesarean section (CS) for placenta previa (PP), previous CS, especially multiple CS, is reported to be associated with massive bleeding. The authors attempted to determine which causes massive bleeding, previous CS per se or previous-CS-associated factors. The need for allogeneic blood transfusion (BT) at CS was set as a marker representing massive bleeding. *Materials and Methods:* This retrospective cohort study involved all 326 patients with PP who delivered in one institute using the same management protocol. The authors evaluated the associations between the number of previous CS, maternal characteristics, and perinatal outcomes, and calculated the odds ratio (OR) for allogeneic BT according to the number of previous CS. *Results:* With an increasing number of previous CS, the following significantly increased: abnormally invasive placenta, anterior placentation, total previa, and ultrasound-detectable lacunae. The rates of allogeneic BT for patients with previous CS of 0×, 1×, and >2× were 6% (16/273), 37% (14/38), and 60% (9/15), respectively ($p < 0.001$). On adjustment for anterior placentation, total previa, and lacunae, ORs (95% confidence interval) of allogeneic BT for previous CS 1× and >2× were 6.3 (2.5-16.4) and 11.4 (3.0-42.2), respectively, with CS 0× being referent. On analysis of 308 (326-18) patients excluding 18 with an abnormally invasive placenta, the adjusted ORs of allogeneic BT for CS 1× and >2× were 3.5 (1.1-10.8) and 6.2 (1.1-37.3), respectively, remaining high. *Conclusion:* The number of prior CS, and, thus the previous CS per se, increases the requirement for allogeneic BT, irrespective of the presence/absence of an AIP, anterior placentation, total previa, or lacunae. Management protocol of PP women with multiple CS should be adapted accordingly.

Key words: Abnormally invasive placenta; Blood transfusion; Number of cesarean sections; Hemorrhage; Placenta previa.

Introduction

Cesarean section (CS) for placenta previa (PP) frequently causes massive bleeding, requiring blood transfusion (BT). The pre-surgical determination of risk factors for massive bleeding enables a multidisciplinary team approach and sufficient blood preparation, possibly reducing the bleeding amount and hemorrhage-related morbidity/mortality. Some previous studies [1, 2] showed that CS for PP with previous CS was more likely to cause massive bleeding or require BT than those without it, which is consistent with the present authors' clinical impression. The following factors are considered to increase the bleeding amount at PP, and, thus, need for allogeneic BT: (i) an abnormally invasive placenta (AIP: accreta, increta, or percreta) [3], (ii) anterior placentation [4, 5], (iii) total PP [6], and (iv) some ultrasound signs [7, 8]. Previous CS (+), compared with no such history, may more frequently accompany these factors for the following reasons: (i) the placenta tends to deeply invade the previous CS scar; (ii, iii) the placental adherence may be firmer in the previous CS scar even without histologically confirmed AIP, causing marked bleeding on placental separation at the site (anterior PP or total PP), and (iv) AIP more frequently accompanies an ultrasound sign of lacunae. The higher the number of previous CS, the more likely these become.

What increases the bleeding amount at CS, previous CS per se, or these accompanying factors? If the former is the case, physicians must not lower their guard against massive bleeding even in the absence of (i-iv) in PP patients with prior CS history. The authors attempted to answer this question with special reference to the number of previous CS, and not merely ±. They focused on allogeneic BT ±, which may represent massive bleeding.

Materials and Methods

The Institutional Review Board of Jichi Medical University Hospital approved this retrospective cohort study in all 326 patients with PP undergoing CS in this institute during a ten-year period, April 2006 - April 2016, during which the authors performed 11,159 deliveries. Some patients were previously reported [9], but the present study purpose and design were completely different. PP was confirmed within three days of CS by ultrasound (vaginal and abdominal), with a multifrequency of 5.0-7.5 MHz.

Published: 15 February 2020

Clin. Exp. Obstet. Gynecol. - ISSN: 0390-6663
XLVII, n. 1, 2020
doi: 10.31083/j.ceog.2020.01.4984

Table 1. — *Maternal characteristics by number of previous cesarean sections.*

	No previous CS (n=273)	1 time previous CS (n=38)	2 times or more previous CS (n=15)	p^a
Maternal age (years)	34.0 (19.0-45.0)[b]	35.5 (27.0-46.0)[b]	35.0 (27.0-43.0)	0.01
Maternal age >35 years	120 (44.0%)	22 (57.9%)	8 (53.3%)	0.229
BMI (kg/m^2)	23.8 (17.0-41.4)	24.1 (19.8-33.6)	25.0 (19.2-30.5)	0.397
Multiparity	116 (42.5%)	38 (100.0%)	15 (100.0%)	-
ART	39 (14.3%)	1 (2.6%)	0 (0.0%)	-
Previous curettage	90 (33.0%)	18 (47.4%)	6 (40.0%)	0.2
Uterine myoma	18 (6.6%)	2 (5.3%)	0 (0.0%)	0.568
Anterior placentation	43 (15.8%)[b,c]	15 (39.5%)[b]	8 (53.3%)[c]	<0.001
Total previa	128 (46.9%)[b,c]	26 (68.4%)[b]	12 (80.0%)[c]	<0.001
Lacunae	45 (16.5%)[b,c]	13 (34.2%)[b]	9 (60.0%)[c]	<0.001
Preoperative maternal Hb	10.5 (8.0-14.3)	10.4 (7.5-11.6)	10.1 (9.2-11.0)	0.079
Preoperative anemia (Hb<10)	60 (22.0%)	9 (23.7%)	6 (40.0%)	0.27
Preparation of autologous blood	223 (81.7%)	29 (76.3%)	9 (60.0%)	0.102

Data are expressed as the median (range) or number (%). CS: cesarean section; BMI: body mass index; ART: conception after artificial reproductive technology; Hb: hemoglobin. [a] Jonckheere-Terpstra trend test or Cochran-Armitage trend test, as appropriate. [b] and [c]: $p < 0.05$ between two figures for Steel-Dwass or Holm's correction tests, as appropriate.

From the charts, the authors extracted the following factors possibly associated with allogeneic BT: maternal age, parity, the number of previous CS, previous curettage ±, uterine myoma ±, main placental location (anterior/posterior), degree of previa (marginal/partial/total), ultrasound-detectable lacunae ±, preoperative anemia (hemoglobin [Hb] <10 g/dL) ±, preparation of autologous blood ±, antepartum bleeding ±, transplacental approach ±, intraoperative blood loss (mL), hysterectomy (planned/emergency) ±, and AIP ±. The number of previous CS was categorized into three: 0, 1, or > 2 times. The authors defined the degree of previa as marginal, partial, or total if the placenta reached over the ultrasound-determined histological internal ostium by 0, < 2 cm, or ≥ 2 cm, respectively, according to the criteria of the Japan Society of Obstetrics and Gynecology [10]. The authors previously showed that anterior PP was an independent risk factor for massive bleeding [4], and, thus, was involved as a possible risk factor. The distance between internal ostium and upper (cephalad) edge of the placenta was measured (abdominal ultrasound or MRI if available): if this distance was longer in anterior than posterior (anterior > posterior) uterine wall, the authors defined it as anterior PP [4]. Ultrasound-detectable lacunae were defined as irregular low-echoic areas larger than 1×1 cm within the placental parenchyma [8]. Although, in principle, the authors attempted to prepare autologous blood for all PP patients with Hb >10 mg/dL, it was not prepared in 64 patients due to: Hb < 10.0 mg/dL (n = 29), no time to prepare (n = 21), impending preterm delivery (n = 8), or refusal (n = 6). The preoperative diagnosis of AIP was made by both repeated ultrasound and MRI as previously described [11]: 1) multiple placental lacunae (> 1 cm diameter), 2) absence of hypoechoic retroplacental zone, and 3) a bulging of serosa-bladder interface into bladder and hyper-vascularity around it, when the placenta was present beneath the bladder. AIP was present in 18 patients, who underwent planned (n = 15) or emergency (n = 3) hysterectomy, with AIP confirmed histologically in all. Patients with pre-surgically diagnosed AIP (n = 15) underwent planned hysterectomy using Matsubara's eight-step procedure [12]. In the remaining three patients, AIP was pre-surgically undiagnosed: AIP became evident during CS (n = 2), or severe atonic bleeding occurred after CS (n = 1), and, thus, hysterectomy was performed. Data on maternal characteristics and perinatal outcomes were retrieved, including the body mass index, conception after artificial reproductive technology, gestational age at delivery, birth weight, Apgar score, and umbilical artery pH. The indication for BT was previously described [9]. In short, blood was transfused in principal with Hb < 6.0 g/dL, systolic blood pressure < 70 mmHg, or estimated blood loss > 2,500 mL. Autologous blood was first transfused when available, and when it was insufficient, allogeneic blood was transfused. Data were retrieved on the amounts of allogeneic BT [containing red cell concentrate (RCC), fresh frozen plasma (FFP), and platelet concentrate (PC)] transfused from the beginning of CS to 24 hours after. Maternal characteristics and perinatal outcomes were analyzed according to the number of previous CS (0 *vs*. 1 *vs*. > 2 times). Next, the authors analyzed the relationship between allogeneic BT ± or AIP ± and the possible risk factors determined by maternal characteristics. Next, after excluding 18 patients with AIP (n = 308, 326-18), the relationship between allogeneic BT ± and possible risk factors was analyzed. Furthermore, excluding 68 patients with hemostatic procedures which may influence the intraoperative blood loss (15 with elective cesarean hysterectomy and/or intra-arterial balloon, 45 intrauterine balloon placement and/or uterine compression suture, seven uterine compression suture only and one intra-arterial balloon only; 15+45+7+1=68), in 258 (326-68) patients we also analyzed the relationship between allogeneic BT ± and possible risk factors. Continuous variables are expressed using the median (range), and categorical variables are given as percentages. The Kruskal-Wallis test with the Steele-Dwass test and Jonckheere-Terpstra trend test were used for comparison of medians. Fisher's exact probability test with Holm's correction test and the Cochran-Armitage trend test were used for comparison of categorical variables. Multivariate logistic regression analysis was used to calculate the odds ratio (OR) and 95% confidence interval (CI) of allogeneic BT or AIP according to number of previous CS. Possible confounding factors determined by maternal characteristics analysis were used for multivariate analyses. Statistical analyses were performed using the software EZR, which is a graphical user interface for R (version 3.0.2) [13]. In all analyses, p-values < 0.05 were considered significant.

Results

Table 1 shows the maternal characteristics of three groups classified according to the number of previous CS:

Table 2. — *Maternal and perinatal outcomes by number of previous cesarean sections.*

	No previous CS (n=273)	1 time previous CS (n=38)	2 times or more previous CS (n=15)	p^a
Antepartum bleeding	119 (43.6%)	21 (55.3%)	7 (46.7%)	0.396
GA at antepartum bleeding (days)	216.0 (151.0 - 261.0)	217.0 (148.0 - 252.0)	215.0 (185.0 - 242.0)	0.865
Transplacental approach	20 (7.3%)	4 (10.5%)	0 (0.0%)	0.417
Intraoperative blood loss (mL)	1350 (280-5000)[c,d]	1730 (465-12 300)[c]	3400 (335-8500)[d]	<0.001
Hysterectomy	3 (1.1%)[c,d]	10 (26.3%)[c,e]	11 (73.3%)[d,e]	<0.001
Planned	0 (0.0%)[c,d]	8 (21.1%)[c]	7 (46.7%)[d]	<0.001
Emergency	3 (1.1%)[c]	2 (5.3%)	4 (26.7%)[c]	<0.001
AIP[b]	1 (0.4%)[c,d]	9 (23.7%)[c,e]	8 (53.3%)[d, e]	<0.001
Autologous BT	125 (56.3%)[d]	21 (72.4%)	9 (100.0%)[d]	0.002
Allogeneic BT	16 (5.9%)[c, d]	14 (36.8%)[c]	9 (60.0%)[d]	<0.001
GA at delivery (days)	260.0 (182.0-270.0)	251.50 (217.0-268.0)	246.0 (202.0-262.0)	<0.001
< 34 weeks	30 (11.0%)	8 (21.1%)	4 (26.7%)	0.059
< 37 weeks	93 (34.1%)[c,d]	25 (65.8%)[c]	12 (80.0%)[d]	<0.001
Birth weight (grams)	2620 (589-4258)	2545 (1322-3520)	2392 (1116-3152)	0.163
< 2,500 grams	100 (36.6%)	18 (47.4%)	8 (53.3%)	0.217
Apgar Score 5 minutes	9.0 (4.0-9.0)[c]	9.0 (2.0-9.0)	7.0 (3.0-9.0)[c]	<0.001
Apgar Score 5 minutes < 7	13 (4.8%)[c,d]	9 (23.7%)[c]	7 (46.7%)[d]	<0.001
Umbilical arterial pH	7.30 (7.13-7.49)	7.32 (7.18-7.40)	7.29 (7.20-7.35)	0.597

Data are expressed as the median (range) or number (%); CS: cesarean section; GA: gestational age; Hb: hemoglobin; BT: blood transfusion; AIP: abnormally invasive placenta. [a] Jonckheere-Terpstra trend test or Cochran-Armitage trend test, as appropriate. [b] Abnormally invasive placenta (AIP) includes placenta accreta, increta, or percreta. [c,d,] and [e]: $p < 0.05$ between two figures for Steel-Dwass or Holm's correction tests, as appropriate.

0 [n = 273 (83.7%)] *vs*. 1 time [n = 38 (11.7%)] *vs*. > 2 times [n = 15(4.6%): 2 times (13) + 3 times (2)]. The incidence of the following three: anterior placentation, total previa, and lacunae, significantly increased with the increasing number of previous CS, but the other characteristics did not.

Table 2 shows the maternal and neonatal outcomes by the number of previous CS. The rates of allogeneic BT for previous CS 0 *vs*. 1 time *vs*. > 2 times were 5.9, 36.8, and 60.0%, respectively. Moreover, with the increasing number of previous CS, intraoperative blood loss and the rates of hysterectomized patients, AIP, and autologous BT also significantly increased, whereas the following did not differ: transplacental approach, antepartum bleeding, birth weight, and umbilical arterial pH. Allogeneic BT was performed in 39 patients (12%: 39/326): RCC in 39 [median: 8 units, range: 2-36, interquartile range (IQR): 6-14], FFP in 30 [median: 6 units, range: 4-38, IQR: 6-14], and PC in 6 [median: 10 units, range: 10-20]. Single units of RCC, FFP, and PC were 140, 120, and 20 mL, respectively. No patients received "FFP only" or "PC only" and, thus, all these 39 patients were referred to as the "allogeneic BT" group.

Table 3 shows the relationships between the risk factors and allogeneic BT ±, together with the odds ratio (OR) for allogeneic BT. As described, the authors chose these potential confounding factors determined by maternal characteristics analysis: anterior placentation, total previa, and lacunae (Table 1), were used for multivariate analyses as covariates. The risk of allogeneic BT in the patients with > 2 times previous CS was approximately ten-fold higher than that in those with no history of previous CS (-) (reference) (OR; 11.4, 95%CI; 3.0-42.2). Table 4 shows the relationships between the risk factors and AIP ±, together with the OR for AIP. The number of previous CS and lacunae were found to be independent risk factors for AIP (OR: 59.7, 166.0, and 21.4, respectively). Table 5 shows the OR of allogeneic BT according to the number of previous CS in 308 patients excluding 18 patients with AIP. The rates of allogeneic BT for previous CS 0 *vs*. 1 time *vs*. > 2 times were 5.5, 20.6, and 28.6%, respectively ($p < 0.001$, the Cochran-Armitage trend test).

Logistic regression analysis also indicated that the ORs of allogeneic BT for CS 1 time and > 2 times were 3.5 (95% CI; 1.1-10.8) and 6.2 (95% CI; 1.1-37.3), respectively, remaining high. Excluding 68 patients with hemostatic procedures which may influence the intraoperative blood loss (i.e., elective cesarean hysterectomy, intrauterine balloon placement, or uterine compression suture), logistic regression analysis of the remaining 258 patients indicated that the number of CS was the only independent risk factor for allogeneic BT (Table 6). Of these 68, AIP was confirmed in 17 patients (94%, 17/18).

Lastly, patients were classified into two groups: previous CS 0 *vs*. > 1 time (expressed as CS ±), with CS > 1 time containing previous CS of both 1 time and > 2 times. The same analyses as described above were performed. The crude OR of allogeneic BT in all 326 (including AIP) *vs*. 308 patients (excluding AIP) was 12.3 (95%CI, 5.8-25.9) *vs*. 4.9 (95%CI, 1.9-12.6), respectively. Its adjusted OR

Table 3. — *Risk factors for allogeneic blood transfusion in all 326 cases.*

Characteristics		Allogeneic BT (+) (n=39)	(–) (n=287)	Crude OR (95% CI)	Adjusted OR[a] (95% CI)
Number of previous CS					
	0	16 (41.0)	257 (89.5)	1.0	1.0
	1	14 (35.9)	24 (8.4)	9.3 (4.0-21.5)	6.3 (2.5-16.4)
	2	9 (23.1)	6 (2.1)	24.1 (7.6-76.1)	11.4 (3.0- 42.2)
Anterior placentation		19 (48.7)	47 (16.4)	5.1 (2.6-10.2)	1.7 (0.7-4.1)
Total previa		33 (84.6)	133 (46.3)	6.6 (2.7-16.1)	2.9 (1.1-7.9)
Lacunae		24 (61.5)	43 (15.0)	9.5 (4.6-19.4)	4.7 (2.0-11.0)

BT: blood transfusion; OR: odds ratio; CS: cesarean section. [a] Significant predictive factors determined by univariate analyses were used for multivariate analyses.

Table 4. — *Risk factors for abnormally invasive placenta in all 326 cases.*

Characteristics		Abnormally invasive placenta (+) (n=18)	(–) (n=308)	Crude OR (95% CI)	Adjusted OR[a] (95% CI)
Number of previous CS					
	0	1 (5.6)	272 (88.3)	1.0	1.0
	1	9 (50.0)	29 (9.4)	84.4 (10.3-690)	59.7 (6.3-567)
	2	8 (44.4)	7 (2.3)	311.0 (34.1-2830)	166.0 (14.2-1940)
Anterior placentation		11 (61.1)	55 (17.9)	7.9 (3.0-20.9)	1.5 (0.3-6.7)
Total previa		17 (94.4)	149 (48.4)	19.2 (2.5-146)	2.9 (0.3-31.1)
Lacunae		16 (88.9)	51 (16.6)	42.8 (9.6-191)	21.4 (3.6-126)

BT: blood transfusion; OR: odds ratio; CS: cesarean section. [a] Significant predictive factors determined by univariate analyses were used for multivariate analyses.

was 7.6 (95%CI, 5.9-25.9) *vs*. 3.9 (95%CI, 1.5-11.0), respectively, with regression covariates being the following three: anterior placentation, total previa, and lacunae, showing that previous CS was an independent risk factor for allogeneic BT at CS for PP.

Discussion

The present study demonstrated that the number of previous CS, irrespective of accompanying factors (AIP, anterior placentation, total previa, or lacunae), were significantly correlated with allogeneic BT during CS for PP. Previous CS per se more frequently led to the requirement of allogeneic BT. Of the various hemorrhage-related morbidities caused by CS for PP, the authors focused their attention on the requirement of allogeneic BT. This is because the measured total bleeding amount does not always reflect its real amount. Some patients can be managed with autologous BT only, meaning that blood loss may be within manageable levels. The requirement of allogeneic BT may reflect the "comprehensive" severity of blood loss, circulatory disturbances, or even coagulopathic tendency on an individual patient basis, and, thus, it possibly shows "the real-world" severity/difficulty of an individual surgery.

The authors also demonstrated that the incidence rates of risk factors for massive bleeding (AIP, anterior placentation, total previa, or lacunae) increased according to the increasing number of previous CS. Prior studies demonstrated that previous CS increased the incidence of these factors [3, 5-8] and additionally, the number of previous CS was associated with the incidence of AIP [3]; however, to the authors' knowledge, the association of other hemorrhagic risk factors (anterior placentation, total previa, and lacunae) and the previous CS number has been an area attracting little attention. The authors here demonstrated that not only previous CS ± but also its number was associated with the incidence of these factors: anterior placentation, total previa, or lacunae.

The rates of having to perform allogeneic BT for PP patients with 1 time and > 2 times previous to CS were 37% (14/38) and 60% (9/15), respectively, approximating to 19% and 59%, respectively, demonstrated by Grobman *et al.* [2]. The present study also showed that the crude OR of allogeneic BT in PP patients with > 1 time (1 time + > 2 times) previous CS was 12.3 (95%CI, 5.8-25.9), also comparable with the 15.9 (95% CI, 12.0-21.0) demonstrated by Rouse *et al.* [1]. However, these two studies [1, 2] did not take some important clinical data into account: AIP, anterior/posterior placentation, or the degree of previa (marginal/partial/total), with all being hemorrhagic risk fac-

Table 5. — *Risk factors for allogeneic blood transfusion in 308 cases excluding 18 cases with an abnormally invasive placenta.*

Characteristics		Allogeneic BT (+) (n=23)	(–) (n=285)	Crude OR (95% CI)	Adjusted OR[a] (95% CI)
Number of previous CS					
	0x	15 (65.2)	257 (90.2)	1.0	1.0
	1x	6 (26.1)	23 (8.1)	4.5 (1.6-12.6)	3.5 (1.1-10.8)
	2x	2 (8.7)	5 (1.8)	6.9 (1.2-38.3)	6.2 (1.1-37.3)
Anterior placentation		10 (43.5)	45 (15.8)	4.1 (1.7-9.9)	2.3 (0.8-6.2)
Total previa		18 (78.3)	131 (46.0)	4.2 (1.5-11.7)	3.0 (1.1-8.8)
Lacunae		9 (39.1)	42 (14.7)	3.7 (1.51-9.14)	2.4 (0.8-6.4)

BT: blood transfusion; OR: odds ratio; CS: cesarean section; [a] Significant predictive factors determined by univariate analyses were used for multivariate analyses.

Table 6. — *Risk factors for allogeneic blood transfusion in 258 cases excluding 68 cases requiring additional hemostatic procedures.*

Characteristics		Allogeneic BT (+) (n=15)	(–) (n=243)	Crude OR (95% CI)	Adjusted OR[a] (95% CI)
Number of previous CS					
	0x	10 (66.7)	219 (90.1)	1.0	1.0
	1x	2 (13.3)	19 (7.8)	2.3 (0.4 -11.3)	1.7 (0.3-9.4)
	2x	3 (20.0)	5 (2.1)	13.1 (2.8-62.9)	9.9 (2.0-50.2)
Anterior placentation		5 (33.3)	32 (13.2)	3.3 (1.1-10.3)	2.2 (0.6-7.6)
Total previa		10 (66.7)	101(41.6)	2.8 (0.9-8.5)	2.1 (0.6-6.7)
Lacunae		6 (40.0)	34(14.0)	4.1 (1.4-12.2)	2.4 (0.7-8.2)

BT: blood transfusion; OR: odds ratio; CS: cesarean section. [a] Significant predictive factors determined by univariate analyses were used for multivariate analyses.

tors as described. Thus, they did not answer the question: which caused the high rate of allogeneic BT, previous CS per se or such accompanying factors? All these factors may have complex relationships with each other, and, thus, the authors excluded the effect of these factors here (AIP, anterior placentation, total previa, or lacunae). Thus, this study clearly indicated that previous CS per se, especially its number, was significantly correlated with allogeneic BT during CS. Why does previous CS more frequently necessitate allogeneic BT during CS in PP, irrespective of AIP, anterior placentation, total previa, and lacunae? Previous CS is a well-known risk factor for AIP [3], and the greater the number of previous CS, the more frequent the incidence of AIP becomes [3].

Patients with previous CS, compared with those without, may more frequently show "subclinical AIP": the placenta may invade "deeper" and may possibly show "local" accreta, i.e., accreta just at or around the CS scar, causing more bleeding. However, the placenta is eventually removed and placental bed biopsy was not performed in these cases, and, thus, AIP could not be histologically confirmed.

Another possibility is that lower segment contraction becomes weaker in the previous uterine scar, which may increase the bleeding amount. The requirement of allogeneic BT was associated with the number of previous CS in PP, but the overall neonatal outcome was not.

Although an increasing number of previous CS was associated with earlier delivery and a lower Apgar score, importantly, the birth weight and umbilical arterial pH did not differ among the three groups (previous CS: 0 *vs*. 1 time *vs*. > 2 times). Grobman *et al.* [2] showed that the number of previous CS in current PP patients did not affect neonatal morbidities (respiratory distress, necrotizing enterocolitis, intraventricular hemorrhage, etc.) or mortalities. Thus, it is suggested that previous CS in PP does not cause a poor overall neonatal outcome. This information may reassure patients with PP who are anxious about neonatal health. Women in Japan, similar to those of many other developed countries, tend to have a small number of children and, thus, the present data did not include women with high-order CS. However, within the present study population, CS per se, especially previous CS > 2 times, increased the need for allogeneic BT in PP.

Various risk factors have been reported to predict massive bleeding, and, thus, the allogeneic BT requirement. AIP, anterior placentation, total previa, and some ultra-

sound signs including lacunae are listed among them. However, it may sometimes be difficult for less experienced physicians to determine them. Previous CS and its number are much more easily identifiable: history-taking suffices. We should not lower our guard against PP with previous CS even when accompanying risk factors are absent: previous CS per se is a risk factor for allogeneic BT in PP.

References

[1] Rouse D.J., MacPherson C., Landon M., Varner M.W., Leveno K.J., Moawad A.H., *et al*.: "Blood transfusion and cesarean delivery". *Obstet. Gynecol.*, 2006, *108*, 891.

[2] Grobman W.A., Gersnoviez R., Landon M.B., Spong C.Y., Leveno K.J., Rouse D.J., *et al*.: "Pregnancy outcomes for women with placenta previa in relation to the number of prior cesarean deliveries". *Obstet. Gynecol.*, 2007, *110*, 1249.

[3] Silver R.M., Landon M.B., Rouse D.J., Leveno K.J., Spong C.Y., Thom E.A., *et al*.: "Maternal morbidity associated with multiple repeat cesarean deliveries". *Obstet. Gynecol.,* 2006, *107*, 1226.

[4] Baba Y., Matsubara S., Ohkuchi A., Usui R., Kuwata T., Suzuki H., *et al*.: "Anterior placentation as a risk factor for massive hemorrhage during cesarean section in patients with placenta previa". *J. Obstet. Gynaecol. Res.,* 2014, *40*, 1243.

[5] To W.W., Leung W.C.: "Placenta previa and previous cesarean section". *Int. J. Gynaecol. Obstet.,* 1995, *51*, 25.

[6] Hendricks M.S., Chow Y.H., Bhagavath B., Singh K.: "Previous cesarean section and abortion as risk factors for developing placenta previa". *J. Obstet. Gynaecol. Res.,* 1999, *25*, 137.

[7] Yang J.I., Lim Y.K., Kim H.S., Chang K.H., Lee J.P., Ryu H.S.: "Sonographic findings of placental lacunae and the prediction of adherent placenta in women with placenta previa totalis and prior Cesarean section". *Ultrasound Obstet. Gynecol*., 2006, *28*, 178.

[8] Hasegawa J., Matsuoka R., Ichizuka K., Mimura T., Sekizawa A., Farina A., *et al*.: "Predisposing factors for massive hemorrhage during Cesarean section in patients with placenta previa". *Ultrasound Obstet. Gynecol*., 2009, *34*, 80.

[9] Baba Y., Takahashi H., Ohkuchi A., Usui R., Matsubara S.: "Which type of placenta previa requires blood transfusion more frequently? A new concept of indiscernible edge total previa". *J Obstet. Gynaecol. Res*., 2016, *42*, 1502.

[10] JSOG. Placenta previa. *In:* Japan Society of Obstetrics and Gynecology (ed). *Glossary of Obstetrics and Gynecology. 2nd ed. Tokyo: Kanehara Co. Ltd.*, 2008, 226.

[11] Takahashi H., Ohkuchi A., Usui R., Suzuki H., Baba Y., Matsubara S.: "Factors Contributing to Massive Blood Loss on Peri-partum Hysterectomy for Abnormally Invasive Placenta: Who Bleeds More?" *Obstet. Gynecol. Int.*, 2016, *2016*, 5349063.

[12] Matsubara S., Kuwata T., Usui R., Watanabe T., Izumi A., Ohkuchi A., *et al*.: "Important surgical measures and techniques at cesarean hysterectomy for placenta previa accreta". *Acta Obstet. Gynecol. Scand.*, 2013, *92*, 372.

[13] Kanda Y.: "Investigation of the freely available easy-to-use software 'EZR' for medical statistics". *Bone Marrow Transplant.*, 2013, *48*, 452.

Corresponding Author
Y. BABA, M.D., PH.D.
Department of Obstetrics and Gynecology
Jichi Medical University, 3311-1 Shimotsuke
Tochigi 329-0498 (Japan)
e-mail: ybabati@jichi.ac.jp