Review

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# Management of massive hemorrhage in pregnant women with placenta previa

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Patients with placenta previa are at risk for intra- and postpartum massive blood loss as well as increased risk of placenta accreta, a type of abnormal placental implantation. This condition can lead to serious obstetric complications, including maternal mortality and morbidity. The risk factors for previa include prior cesarean section, multiparity, advanced maternal age, prior placenta previa history, prior uterine surgery, and smoking. The prevalence of previa parturients has increased due to the rising rates of cesarean section and advanced maternal age. For these reasons, we need to identify the risk factors for previa and identify adequate management strategies to respond to blood loss during surgery. This review evaluated the diagnosis of placenta previa and placenta accreta and assessed the risk factors for previa-associated bleeding prior to cesarean section. We then presented intraoperative anesthetic management and other interventions to control bleeding in patients with previa expected to experience massive hemorrhage and require transfusion.

**Keywords:** Balloon occlusion; Cesarean section; Obstetrical anesthesia; Placenta accreta; Placenta previa; Postpartum hemorrhage; Uterine artery embolization.

## INTRODUCTION

Placenta previa (PP) is defined as abnormal placental implantation in the lower uterine segment. The condition in which the placenta completely overlies the internal cervical os, is termed placenta previa totalis (PPT). PP occasionally combines with placenta adhesion and abnormal placentation, referred to as placenta accreta, which includes accreta, increta, and percreta. These conditions can cause massive peripartum hemorrhage, which increases the probability of requiring blood transfusions [1]. Thus, PP is associated with maternal morbidity and mortality [2,3]. The risk of life-saving hysterectomy after cesarean section (CS) for PP is 30 times higher than that for patients without PP, in addition to longer hospital stay after delivery [4].

Antenatal diagnosis and risk estimation for massive blood loss in parturients with PP would allow adequate preparation and multidisciplinary approaches to improve maternal morbidity and mortality. Therefore, this review focused on risk assessment and anesthetic considerations for parturients with PP in whom massive hemorrhage is expected during CS. We describe these considerations according to three categories: preoperative considerations, anesthetic management, and interventions.

## PREOPERATIVE CONSIDERATIONS

### Identification of women at risk for PP bleeding

Ultrasound (US) is considered the first-line method for

detecting abnormal placentation in the prenatal period. The location of the placenta (anterior, posterior, and lateral) can be identified on transvaginal US images. An anterior PPT or previous cesarean scar were identified as independent factors for transfusion and hysterectomy in a retrospective study [5,6].

After confirming the placenta location, US findings suggesting a risk of massive blood loss and placental adhesion should be checked. Many studies have reported sonographic findings predicting placenta accreta. Lacunae space (an irregular area of low echogenicity larger than 1 cm × 1 cm in the placental parenchyma) was strongly associated with placenta accreta [6,7]. Lacunae were graded according to their appearance and number, with Grades 2 and 3 at high risk for placental invasion. Grade 2 is defined as the presence of 4–6 lacunae that tend to be larger and more irregular in shape, while Grade 3 is characterized by many large and bizarrely-shaped lacunae throughout the placenta [8]. Sponge-like findings of the cervix wall (five or more hypoechogenic areas > 5 mm in diameter), lack of retroplacental clear zone (the clear zone; sonolucent zone between the placenta and myometrium), thinning (≤ 1 mm) of the myometrium, bridging vessels from the placenta to the uterine-bladder interface, and uterine-bladder interface thinning are also suggestive of abnormal placentation [6,7,9,10] (Fig. 1). Magnetic resonance imaging (MRI) can also be used when US examination findings are inconclusive, particularly in women with abnormal placentation. In a systematic review and meta-analysis report, MRI was highly accurate for the detection of placental invasion presence, depth, and topography (Fig. 2). Further, MRI and US showed similar performance in detecting the presence of invasive placentation [11]. However, the prenatal diagnosis accuracy using US exam may be insufficient, with a sensitivity of 0.53–0.85 and a specificity of 0.71–0.89 [10–12]. US alone has limitations for the prediction of bleeding in the intra- and postpartum periods. However, the clinical characteristics should also be considered.

The cause of placental implantation in the lower uterus segment is unclear. Therefore, it has highly associated with previous endometrial damages, and uterine scarring due to myomectomy or CS, prior PP, and multiparity [13]. The clinical risk factors associated with PP and placenta adhesion have been well established, including advanced maternal age, multiparity, multiple gestations, and smoking [13,14]. A large prospective study reported that as the number of CSs increased from 1 to 2 and ≥ 3, the probability of accreta increased from 11% to 40% and ≥ 61%, respectively [15]. After CS, the layer of the decidua becomes thinner, which may fail to reconstitute the decidual basalis/endometrium. This may further promote placental accreta to a previous lower uterine segment scar [5,16]. Repeated CS, PP, especially anterior and/or CS scar, placenta adhesion, and older maternal age increased the risk of massive peripartum hemorrhage and transfusion [9,17]. The predictive factors for peripartum hysterectomy in women were prior CS (adjusted odds ratio [aOR], 23.1), major PP including partial and complete previa (aOR, 14.6), US suspicion of
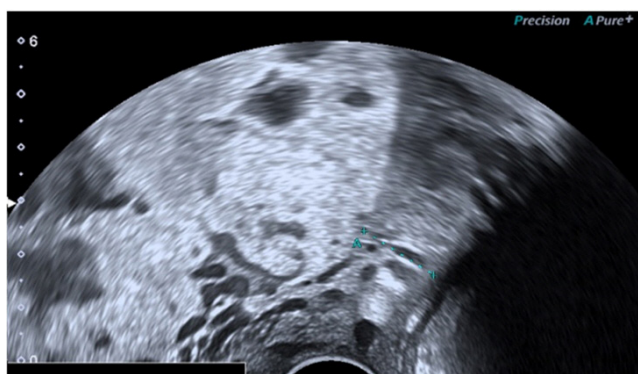


**Fig. 1.** Preoperative ultrasonography findings of a patient with anterior placenta previa indicating suspicious lacunar space, sponge-like findings in the cervix wall, and lack of retroplacental clear zone.



**Fig. 2.** Preoperative magnetic resonance imaging of a patient with anterior placenta previa and placenta accreta suggesting placenta adhering to the bladder wall (arrow).

placenta accreta (aOR, 42.4), and gestational age less than 34 weeks (aOR, 9.3) [18].

In clinical situations, risk estimation by combining all of these factors would be more predictable than clinical variables or imaging findings of previa and placental invasion alone. Thus, based on both clinical characteristics and imaging findings, researchers have developed prediction indexes or scoring systems to evaluate the risk of placental invasion and predict massive blood loss or the need for allogeneic blood transfusion.

### Prediction index and score

The "Placenta Accreta Index" assigned points for ≥ 2 CSs (3.0 points), lacunae grade 2 (1.0 point) and 3 (3.5 points), sagittal smallest myometrial thickness (≤ 1 mm, > 1 but ≤ 3 mm, > 3 but ≤ 5 mm: 1.0, 0.5, and 0.25 points, respectively), anterior PP (1.0 point), and bridging vessels (0.5 points) [7]. This index indicated the probability of placental invasion; for example, > 5 points showed a 69% probability of invasion (95% confidence interval, 50–83).

Baba et al. [19] reported three independent risk factors that were associated with blood transfusion in patients with PP: a) lacunae (placental hypoechoic areas) that represented abnormal placental adhesion in imaging, b) previous CS, and c) placenta covering the previous CS scar, indicating anterior or central placenta. Kim et al. [20] developed a scoring system to predict massive postpartum transfusion that considered the following five factors: a) suspicion of placental adhesion on imaging (2 points), b) previous CS (0, 1, ≥ 2: 0, 1, and 2 points, respectively), c) gestational age below 37 weeks (1 point), d) anterior placenta (1 point), and e) sponge-like appearance of the cervix (1 point). They showed that the combination of previa, clinical features, and suspicion of placental invasion was more predictive than only a suspicion of placental adhesion, with areas under the receiver operating characteristic curve (AUC) of 0.84 and 0.67, respectively. Parturients with 4 of 7 points, showed a 72% probability of massive transfusion. Another scoring model included maternal age ≥ 35 years, fetal non-cephalic presentation, PPT, anterior placenta, uteroplacental hypervascularity, and multiple lacunae to predict postpartum massive blood loss [21]. Recently, Liu et al. [22] proposed the "Hysterectomy Index in Placenta Previa with Prior Cesarean" to predict the risk of cesarean hysterectomy. The parameters from previous studies were included in this report on the risk of placental in-

vasion. Among parturients fulfilling all three parameters; namely, vascular lacunae on US imaging, central PP, and loss of normal hypoechoic retroplacental zone, the predicted incidence of hysterectomy was 90.4%.

Based on the scoring system or predictive model, surgeons and anesthesiologists should identify patients who are at risk for peripartum blood loss and hysterectomy to prepare multidisciplinary strategies, including massive transfusion protocols, embolization, artery ballooning, and lastly, hysterectomy. We next discuss anesthetic management.

## ANESTHETIC MANAGEMENT FOR CS

### Anesthesia and catheterization based on a scoring system

According to the scoring system consisting of the five factors mentioned above [20], score indexes below 3 of 7 points are considered to be at low risk of massive hemorrhage (massive transfusion probability of 44%) and, since most cases are hemodynamically stable, regional anesthesia is preferred. Score indexes over 4 points indicate a high risk of massive hemorrhage for which general anesthesia and central venous catheterization should be considered in preparation for massive transfusion, defined as the transfusion of ≥ 8 units of red blood cells [20].

### Anesthetic method

The choice of anesthetic method for parturients with PP undergoing CS has long been controversial. Some authors have suggested the application of regional anesthesia in elective CS but not in emergencies with major hemorrhage [23]. Other authors have proposed general anesthesia over regional anesthesia for all CS patients with PP, as regional anesthesia can exacerbate hypotension and reduce sympathetic response to hypovolemia [24]. Of concern is that when massive bleeding occurs, the sympathetic blockade induced by regional anesthesia makes it difficult to maintain adequate blood pressure. However, evidence for the use of regional anesthesia in CS with PP has recently been reported [25]. Since vasoconstriction associated with sympathetic response to maintain arterial blood pressure is not possible under regional anesthesia, it has a protective effect to reduce the risk of underestimating blood loss leading to under-transfusion [26,27]. A retrospective survey re-

ported significantly reduced estimated blood loss and need for blood transfusion compared to those for general anesthesia [26,28]. Another area of concern regarding regional anesthesia is the surgery duration. In the case of CS in patients with PP, where massive bleeding is possible or has occurred, general anesthesia or conversion from regional to general anesthesia should be considered [29,30]. Although an epidural catheter can prolong anesthesia time, it can also lead to the exacerbation of hypotension and local anesthetic toxicity. In addition, to select the appropriate anesthesia between general and regional anesthesia, patient discomfort and suboptimal operating conditions should also be considered [29].

## Massive transfusion

Massive hemorrhage is a recognized complication of PP. The optimal predelivery transfusion planning strategy requires coordination and communication among all perioperative disciplines, including anesthesiologists, obstetricians, nursing personnel, blood bank staff, and interventional radiologists. A massive transfusion protocol should be in place to address preoperative blood component preparation and intraoperative management. Although there is a report on autologous blood donation programs that have reduced the need for allogeneic blood transfusions in high risk parturients, autologous donation is not recommended because severe postpartum hemorrhage is rarely anticipated and problems such as bacterial contamination and human errors exist [31,32]. Hematology and coagulation laboratory values must be evaluated before surgery. The initial measurement of hemoglobin level is useful as a baseline measure and repeated evaluation provides information on the degree of severity of bleeding and anemia [32,33]. After analyzing risk factors by utilizing the previously described scoring system to predict massive transfusion in PP [19-22], invasive monitoring with arterial catheterization, central catheterization with a large-bore catheter, and noninvasive or minimally invasive cardiac output monitoring can be applied [34,35]. Even without proper catheterization before CS, if the bleeding is not rapidly controlled during surgery, the placement of large venous access (16 gauge or more) should be considered [32]. Permissive hypotension during the bleeding phase can be considered, aiming for a mean arterial pressure of 55–65 mmHg, with the mean arterial pressure normalized when the bleeding becomes acceptable [32]. One randomized controlled trial reported that restrictive crystalloid resuscitation (1–2 ml of crystalloid for every 1 ml of blood loss) was helpful for a low incidence of fibrinogen depletion and coagulopathy [36]. Active and early warming of the parturient to maintain normothermia is recommended to reduce a decrease in hemoglobin [37]. Vasopressors such as ephedrine and phenylephrine can help patients with hypovolemic status to maintain adequate blood pressure. Infusion or bolus of norepinephrine may be considered and have been actively introduced recently in CS [38]. The administration of tranexamic acid (1 g intravenously), an antifibrinolytic agent that reduces blood loss and blood transfusion in CS [39,40], may help reduce postpartum hemorrhage. However, the possible side effects and thromboembolic risk of tranexamic acid must be taken into account when considering its safety [32,41]. Regarding red blood cell transfusion, in most patients not accompanied by massive bleeding, the recent transfusion trigger has been gradually lowered to less than 7 g/dl and a restrictive transfusion strategy has been recommended [42,43]. However, this strategy is not applicable to massive bleeding. If massive bleeding introduced by PP develops, it is important to shift to the massive transfusion protocol to prevent the various morbidities that can be caused by severe anemia [44]. Generally, fresh frozen plasma transfusion is a part of massive transfusion protocols and should be considered if coagulopathy is suspected or confirmed by laboratory tests [45]. Likewise, platelet concentrate transfusion should be considered according to the massive transfusion protocol guided by abnormalities in platelet counts in laboratory tests or platelet function impairment as measured by various platelet function tests, including thromboelastography and rotational thromboelastometry (ROTEM) [45]. In massive hemorrhage, fibrinogen levels affect bleeding severity. The risk of severe postpartum hemorrhage increases for a fibrinogen level below 2 g/L [46]. Therefore, when severe hemorrhage occurs due to PP during CS, fibrinogen levels should be monitored early so that cryoprecipitate or fibrinogen concentrate can be administered [47]. The aforementioned ROTEM can be helpful. When FIBTEM A5 is less than 12 mm, substitution should be considered because this fibrinogen concentration corresponds to 2 g/L [48]. The benefit of the transfusion of blood components and coagulation factors according to the massive transfusion protocol is the prevention of transfusion delay and correction of coagulopathy [32].

## RADIOLOGIC INTERVENTIONS

### Embolization and balloon occlusion

Several attempts have been used to minimize blood loss in patients with abnormal placentation. Uterine artery embolization to control postpartum hemorrhage was first reported in 1979 [49]. This procedure is considered less invasive than arterial ligation, which has a higher failure rate of more than 50% due to the rich collateral circulation of the pelvis [50].

Uterine artery embolization has a median success rate of 89% with good clinical outcomes [51,52]. In the case of a patient with PPT and uterine myomas, uterine artery embolization was preoperatively planned and intraoperatively performed immediately after delivery of the fetus before removal of the placenta during CS [53]. Placental expulsion was performed without complications after successful uterine artery embolization using gel foam particles [53]. Another method to decrease postpartum hemorrhage induced by PP is transcatheter arterial balloon occlusion. For patients with PP suspected to have placental adhesion leading to perioperative massive hemorrhage, prophylactic transcatheter arterial balloon occlusion can be planned in both internal iliac arteries before CS. Although some studies have reported a lack of benefits or complications related to radiologic intervention [54,55], most were case reports or case studies. However, no differences in complications were observed among other large studies or prospective studies, in which prophylactic transcatheter arterial balloon occlusion resulted in reduced blood loss and transfusion requirement for parturients at risk for massive hemorrhage [56–59]. In the clinical application of the radiologic interventions mentioned above, there are various difficulties such as the catheterization timing, intervention and CS location, patient movement, anesthetic method, and fluoroscopic equipment. Therefore, to ensure patient safety and achieve successful interventions and CS, a full discussion of perioperative disciplines including interventional radiologists, anesthesiologists, and obstetricians is required.

## CONCLUSION

PP can occasionally cause massive hemorrhage, leading to poor maternal and neonatal outcomes. Various studies have sought to identify the risk factors for patients with PP

associated with massive hemorrhage and maternal morbidity. Based on patient information and test findings, the direction of anesthesia and surgery and whether to implement a massive transfusion protocol can be determined by cooperation and discussion among the various disciplines related to CS. In addition, radiologic interventions, such as uterine artery embolization and transcatheter arterial balloon occlusion, may be helpful for advanced anesthetic management.

## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

## AUTHOR CONTRIBUTIONS

Conceptualization: Hyun-Seok Cho. Visualization: Hee-Sun Park. Writing - original draft: Hee-Sun Park. Writing - review & editing: Hyun-Seok Cho. Supervision: Hyun-Seok Cho.

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## REFERENCES

1. Lal AK, Hibbard JU. Placenta previa: an outcome-based cohort study in a contemporary obstetric population. Arch Gynecol Obstet 2015; 292: 299-305.
2. Say L, Chou D, Gemmill A, Tunçalp Ö, Moller AB, Daniels J, et al. Global causes of maternal death: a WHO systematic analysis. Lancet Glob Health 2014; 2: e323-33.
3. Fan D, Xia Q, Liu L, et al. The incidence of postpartum hemorrhage in pregnant women with placenta previa: a systematic review and meta-analysis. PLoS One 2017; 12: e0170194.
4. Crane JM, Van den Hof MC, Dodds L, Armson BA, Liston R. Maternal complications with placenta previa. Am J Perinatol 2000; 17: 101-5.
5. Young BC, Nadel A, Kaimal A. Does previa location matter? Surgical morbidity associated with location of a placenta previa. J Perinatol 2014; 34: 264-7.
6. 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. Ultra-

sound Obstet Gynecol 2009; 34: 80-4.

7. Rac MW, Dashe JS, Wells CE, Moschos E, McIntire DD, Twick-ler DM. Ultrasound predictors of placental invasion: the Pla-centa Accreta Index. Am J Obstet Gynecol 2015; 212: 343.e1-7.

8. Finberg HJ, Williams JW. Placenta accreta: prospective sono-graphic diagnosis in patients with placenta previa and prior cesarean section. J Ultrasound Med 1992; 11: 333-43.

9. Hasegawa J, Nakamura M, Hamada S, Matsuoka R, Ichizuka K, Sekizawa A, et al. Prediction of hemorrhage in placenta previa. Taiwan J Obstet Gynecol 2012; 51: 3-6.

10. Bowman ZS, Eller AG, Kennedy AM, Richards DS, Winter TC 3rd, Woodward PJ, et al. Accuracy of ultrasound for the predic-tion of placenta accreta. Am J Obstet Gynecol 2014; 211: 177. e1-7.

11. D'Antonio F, Iacovella C, Palacios-Jaraquemada J, Bruno CH, Manzoli L, Bhide A. Prenatal identification of invasive placen-tation using magnetic resonance imaging: systematic review and meta-analysis. Ultrasound Obstet Gynecol 2014; 44: 8-16.

12. Dwyer BK, Belogolovkin V, Tran L, Rao A, Carroll I, Barth R, et al. Prenatal diagnosis of placenta accreta: sonography or mag-netic resonance imaging? J Ultrasound Med 2008; 27: 1275-81.

13. Rao KP, Belogolovkin V, Yankowitz J, Spinnato JA 2nd. Abnor-mal placentation: evidence-based diagnosis and management of placenta previa, placenta accreta, and vasa previa. Obstet Gynecol Surv 2012; 67: 503-19.

14. Miller DA, Chollet JA, Goodwin TM. Clinical risk factors for placenta previa-placenta accreta. Am J Obstet Gynecol 1997; 177: 210-4.

15. Silver RM, Landon MB, Rouse DJ, Leveno KJ, Spong CY, Thom EA, et al. National Institute of Child Health and Human Devel-opment Maternal-Fetal Medicine Units Network. Maternal morbidity associated with multiple repeat cesarean deliveries. Obstet Gynecol 2006; 107: 1226-32.

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

17. Ohkuchi A, Onagawa T, Usui R, Koike T, Hiratsuka M, Izumi A, et al. Effect of maternal age on blood loss during parturition: a retrospective multivariate analysis of 10,053 cases. J Perinat Med 2003; 31: 209-15.

18. Giambattista E, Ossola MW, Duiella SF, Crovetto F, Acaia B, Somigliana E, et al. Predicting factors for emergency peripar-tum hysterectomy in women with placenta previa. Arch Gyne-col Obstet 2012; 285: 901-6.

19. Baba Y, Ohkuchi A, Usui R, Suzuki H, Kuwata T, Matsubara S. Calculating probability of requiring allogeneic blood transfu-sion using three preoperative risk factors on cesarean section for placenta previa. Arch Gynecol Obstet 2015; 291: 281-5.

20. Kim JW, Lee YK, Chin JH, Kim SO, Lee MY, Won HS, et al. De-velopment of a scoring system to predict massive postpartum transfusion in placenta previa totalis. J Anesth 2017; 31: 593-600.

21. Lee JY, Ahn EH, Kang S, Moon MJ, Jung SH, Chang SW, et al. Scoring model to predict massive post-partum bleeding in pregnancies with placenta previa: a retrospective cohort study. J Obstet Gynaecol Res 2018; 44: 54-60.

22. Liu B, Deng S, Lin M, Chen Y, Cai J, Yang J, et al. Prediction of cesarean hysterectomy in placenta previa complicated with prior cesarean: a retrospective study. BMC Pregnancy Child-birth 2020; 20: 81.

23. Shnider SM, Levinson G. Anesthesia for obstetrics. In: Anesthe-sia. 2nd ed. Edited by Miller RD: New York, Churchill Living-stone. 1986, pp 1661-728.

24. Shnider SM, Levinson G. Anesthesia for obstetrics. 3rd ed. Bal-timore, Williams & Wilkins. 1993. p. 385-94.

25. Bonner SM, Haynes SR, Ryall D. The anaesthetic management of caesarean section for placenta praevia: a questionnaire sur-vey. Anaesthesia 1995; 50: 992-4.

26. Parekh N, Husaini SW, Russell IF. Caesarean section for placen-ta praevia: a retrospective study of anaesthetic management. Br J Anaesth 2000; 84: 725-30.

27. Shibata K, Yamamoto Y, Murakami S. Effects of epidural anes-thesia on cardiovascular response and survival in experimen-tal hemorrhagic shock in dogs. Anesthesiology 1989; 71: 953-9.

28. McShane PM, Heyl PS, Epstein MF. Maternal and perinatal morbidity resulting from placenta previa. Obstet Gynecol 1985; 65: 176-82.

29. LaPlatney DR, O'Leary JA. Anesthetic considerations in cesare-an hysterectomy. Anesth Analg 1970; 49: 328-30.

30. Chestnut DH, Dewan DM, Redick LF, Caton D, Spielman FJ. Anesthetic management for obstetric hysterectomy: a multi-in-stitutional study. Anesthesiology 1989; 70: 607-10.

31. Yamamoto Y, Yamashita T, Tsuno NH, Nagamatsu T, Okochi N, Hyodo H, et al. Safety and efficacy of preoperative autologous blood donation for high-risk pregnant women: experience of a large university hospital in Japan. J Obstet Gynaecol Res 2014; 40: 1308-16.

32. Muñoz M, Stensballe J, Ducloy-Bouthors AS, Bonnet MP, De Robertis E, Fornet I, et al. Patient blood management in obstet-rics: prevention and treatment of postpartum haemorrhage. A NATA consensus statement. Blood Transfus 2019; 17: 112-36.

33. Green L, Knight M, Seeney F, Hopkinson C, Collins PW, Collis RE, et al. The haematological features and transfusion man-agement of women who required massive transfusion for ma-jor obstetric haemorrhage in the UK: a population based study.

Br J Haematol 2016; 172: 616-24.

34. Toledano RD, Leffert LR. Anesthetic and obstetric management of placenta accreta: clinical experience and available evidence. Curr Anesthesiol Rep 2017; 7: 93-102.

35. Burtelow M, Riley E, Druzin M, Fontaine M, Viele M, Goodnough LT. How we treat: management of life-threatening primary postpartum hemorrhage with a standardized massive transfusion protocol. Transfusion 2007; 47: 1564-72.

36. Wikkelsø AJ, Edwards HM, Afshari A, Stensballe J, Langhoff-Roos J, Albrechtsen C, et al; FIB-PPH trial group. Pre-emptive treatment with fibrinogen concentrate for postpartum haemorrhage: randomized controlled trial. Br J Anaesth 2015; 114: 623-33.

37. Yokoyama K, Suzuki M, Shimada Y, Matsushima T, Bito H, Sakamoto A. Effect of administration of pre-warmed intravenous fluids on the frequency of hypothermia following spinal anesthesia for Cesarean delivery. J Clin Anesth 2009; 21: 242-8.

38. Ngan Kee WD, Lee SW, Ng FF, Tan PE, Khaw KS. Randomized double-blinded comparison of norepinephrine and phenylephrine for maintenance of blood pressure during spinal anesthesia for cesarean delivery. Anesthesiology 2015; 122: 736-45.

39. Sekhavat L, Tabatabaii A, Dalili M, Farajkhoda T, Tafti AD. Efficacy of tranexamic acid in reducing blood loss after cesarean section. J Matern Fetal Neonatal Med 2009; 22: 72-5.

40. WOMAN Trial Collaborators. Effect of early tranexamic acid administration on mortality, hysterectomy, and other morbidities in women with post-partum haemorrhage (WOMAN): an international, randomised, double-blind, placebo-controlled trial. Lancet 2017; 389: 2105-16.

41. Imbesi S, Nettis E, Minciullo PL, Di Leo E, Saija A, Vacca A, et al. Hypersensitivity to tranexamic acid: a wide spectrum of adverse reactions. Pharm World Sci 2010; 32: 416-9.

42. Holst LB, Petersen MW, Haase N, Perner A, Wetterslev J. Restrictive versus liberal transfusion strategy for red blood cell transfusion: systematic review of randomised trials with meta-analysis and trial sequential analysis. BMJ 2015; 350: h1354.

43. Villanueva C, Colomo A, Bosch A, Concepción M, Hernandez-Gea V, Aracil C, et al. Transfusion strategies for acute upper gastrointestinal bleeding. N Engl J Med 2013; 368: 11-21.

44. Prick BW, Jansen AJ, Steegers EA, Hop WC, Essink-Bot ML, Uyl-de Groot CA, et al. Transfusion policy after severe postpartum haemorrhage: a randomised non-inferiority trial. BJOG 2014; 121: 1005-14.

45. British Committee for Standards in Haematology, Stainsby D, MacLennan S, Thomas D, Isaac J, Hamilton PJ. Guidelines on the management of massive blood loss. Br J Haematol 2006; 135: 634-41.

46. Charbit B, Mandelbrot L, Samain E, Baron G, Haddaoui B, Keita H, et al; PPH Study Group. The decrease of fibrinogen is an early predictor of the severity of postpartum hemorrhage. J Thromb Haemost 2007; 5: 266-73.

47. Jensen NH, Stensballe J, Afshari A. Comparing efficacy and safety of fibrinogen concentrate to cryoprecipitate in bleeding patients: a systematic review. Acta Anaesthesiol Scand 2016; 60: 1033-42.

48. Mallaiah S, Barclay P, Harrod I, Chevannes C, Bhalla A. Introduction of an algorithm for ROTEM-guided fibrinogen concentrate administration in major obstetric haemorrhage. Anaesthesia 2015; 70: 166-75.

49. Heaston DK, Mineau DE, Brown BJ, Miller FJ Jr. Transcatheter arterial embolization for control of persistent massive puerperal hemorrhage after bilateral surgical hypogastric artery ligation. AJR Am J Roentgenol 1979; 133: 152-4.

50. Evans S, McShane P. The efficacy of internal iliac artery ligation in obstetric hemorrhage. Surg Gynecol Obstet 1985; 160: 250-3.

51. Likis FE, Sathe NA, Morgans AK, Hartmann KE, Young JL, Carlson-Bremer D, et al. Management of postpartum hemorrhage. Rockville, U.S. Department of Health and Human Services. 2015.

52. Pelage JP, Le Dref O, Mateo J, Soyer P, Jacob D, Kardache M, et al. Life-threatening primary postpartum hemorrhage: treatment with emergency selective arterial embolization. Radiology 1998; 208: 359-62.

53. Lee JW, Song IA, Ryu J, Park HP, Jeon YT, Hwang JW. Anesthetic management of a parturient with placenta previa totalis undergoing preventive uterine artery embolization before placental expulsion during cesarean delivery: a case report. Korean J Anesthesiol 2014; 67: 279-82.

54. Shrivastava V, Nageotte M, Major C, Haydon M, Wing D. Case-control comparison of cesarean hysterectomy with and without prophylactic placement of intravascular balloon catheters for placenta accreta. Am J Obstet Gynecol 2007; 197: 402. e1-5.

55. Bishop S, Butler K, Monaghan S, Chan K, Murphy G, Edozien L. Multiple complications following the use of prophylactic internal iliac artery balloon catheterisation in a patient with placenta percreta. Int J Obstet Anesth 2011; 20: 70-3.

56. Cho YJ, Oh YT, Kim SY, Kim JY, Jung SY, Chon SJ, et al. The efficacy of pre-delivery prophylactic trans-catheter arterial balloon occlusion of bilateral internal iliac artery in patients with suspected placental adhesion. Obstet Gynecol Sci 2017; 60: 18-25.

57. Cali G, Forlani F, Giambanco L, Amico ML, Vallone M, Puccio G, et al. Prophylactic use of intravascular balloon catheters in

women with placenta accreta, increta and percreta. Eur J Obstet Gynecol Reprod Biol 2014; 179: 36-41.

58. Carnevale FC, Kondo MM, de Oliveira Sousa W Jr, Santos AB, da Motta Leal Filho JM, Moreira AM, et al. Perioperative temporary occlusion of the internal iliac arteries as prophylaxis in cesarean section at risk of hemorrhage in placenta accreta.

Cardiovasc Intervent Radiol 2011; 34: 758-64.

59. Ji SM, Cho C, Choi G, Song J, Kwon MA, Park JH, et al. Successful management of uncontrolled postpartum hemorrhage due to morbidly adherent placenta with Resuscitative endovascular balloon occlusion of the aorta during emergency cesarean section - a case report -. Anesth Pain Med 2020; 15: 314-8.