Perioperative patient blood management during parallel transverse uterine incision cesarean section in patient with pernicious placenta previa: A retrospective cohort analysis

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Research article

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Abstract

Background Pernicious placenta previa (PPP) is the main cause of severe obstetric postpartum hemorrhage (PPH) and hysterectomy and often requires donor blood transfusion. Prophylactic internal iliac artery (IIA) balloon occlusion (BO) combined with cell salvage is increasingly being deployed in parallel transverse uterine incision (PTUI) cesarean section (CS). The aim of this study was to explore the differences in blood management in PTUI CS with or without prophylactic IIA BO and to evaluate the safety and efficacy of cell salvage to reduce the need for donor blood transfusion during PTUI CS. Methods This retrospective study included all women who were diagnosed with PPP and PA and underwent PTUI CS from October 1, 2016, to October 31, 2018. Sixty-four patients were included: 34 underwent prophylactic IIA BO (IIA group), while 30 were treated without prophylactic IIA BO (control group). The primary outcome was a composite measure of perioperative blood management outcomes, including the estimated blood loss (EBL), donor blood transfusion, salvaged blood returned, fresh frozen plasma (FFP), pre- and postoperative serum hemoglobin(Hb) and hematocrit (HCT). In addition, the baseline conditions of mother and neonates were compared. Results The EBL was significantly higher in the IIA group compared to the control group (2883.5 ML in the IIA group versus 1868.7 ML in the control group, P=0.001). Overall, the donor blood transfusion rate was 23.5% (8/34), averaging 4.2 U, in the IIA group versus 30% (9/30), averaging 3.4 U, in the control group, which were not significantly different. The FFP transfusion rate was 47%, averaging 765.6 ml, in the IIA group versus 20%, averaging 816.7 ml, in the control group. In the IIA group, 97.1% used cell savage and had salvaged blood returned, averaging 954.9 ml. In the control group, 90% had salvaged blood returned, averaging 617.9 ml. No cases of amniotic fluid embolism were observed with leukocyte depletion filters. Conclusion Prophylactic IIA BO during PTUI CS in women with PPP and PA does not lead to a statistically significant reduction in EBL. Cell salvage was associated with a reduction in the rate of donor blood transfusion during PTUI CS.

Background

Childbirth by cesarean section (CS) is on the rise worldwide [1], especially in China because of the liberalization of the two-child policy. Massive blood loss is an important cause of emergency hysterectomy [2], maternal death [3] among women with pernicious placenta previa (PPP) and placenta accreta (PA) undergoing a cesarean birth [4]. Donor red blood cell (RBC) transfusion is performed when the mother has severe anemia because of arrest of hemorrhage or when the estimated operative blood loss is life-threatening. RBC units for use in allogeneic transfusion are finite. In addition to optimizing red cell mass and managing anemia, the treatment of major excessive hemorrhage includes strategies to minimize blood loss. Of those strategies, parallel transverse uterine incision (PTUI) CS, which could preserve the uterus, was used recently in our hospital to control bleeding in patients with PPP and PA [5]. Preoperative patient blood management (PBM) is very important for those high-risk patients undergoing PTUI CS.

In addition to surgical procedures, several hemostatic techniques to minimize blood loss have been performed in patients with PPP and PA during CS, including the use of balloon occlusion (BO) [6-9] alone in the internal iliac artery (IIA) and intraoperative cell salvage [10], which may reduce the pressure on allogeneic transfusion. Prophylactic IIA BO and cell salvage are increasingly being deployed during CS when there is a high-risk of hemorrhage. In theory, those techniques reduce the infectious and allergenic risks associated with donor blood transfusion and the need for such transfusions in a wide spectrum of surgical disciplines [11-12]. The use of endovascular interventional procedures has been described in the management of obstetric hemorrhage of various causes, but current literature about its feasibility, efficacy and safety in PTUI CS is still inadequate.

In our hospital, PTUI CS with or without IIA BO was performed in patients who want to preserve the uterus among those with PPP and PA. In these patients, general anesthesia was performed. To date, only very limited data about PBM management of PTUI CS exist, and the effects of bilateral IIA BO on reducing bleeding during PTUI CS remain unknown. Our primary aim in this study, therefore, was the exploration of differences in PBM management of PTUI CS with or without prophylactic bilateral IIA BO. The second aim was to determine whether the routine use of cell salvage during PTUI CS in women with PPP and PA could safely reduce the need for donor blood transfusion.

Methods

Study setting

This retrospective study was approved by the Ethics Committee of the West China Second University Hospital of Sichuan University (No. 041/2018) and registered at the Chinese clinical trial registry (No. ChiCTR1900020774).

Patient population

This study protocol was performed at the West China Second University Hospital, Sichuan University. We employed residents in anesthesiology and the intensive care unit for this study. We performed a retrospective cohort of women who were diagnosed with PPP and underwent PTUI CS at our institution from October 1, 2016 to October 31, 2018. Detailed data collection for baseline conditions and perioperative anesthesia management outcomes were obtained retrospectively by review of the electronic medical records by an anesthesiologist (Lan Wu). Validation of data after entry was performed by a senior author (Yushan Ma and Xiaoqin Jiang). We analyzed anonymized data only.

In total, 382 patients with PPP and PA were reviewed retrospectively, and only 64 patients who met the requirements were included. The inclusion criteria were as follows: (1) Suspected diagnosis of PPP and PA was confirmed by preoperative magnetic resonance imaging (MRI) before planned caesarean delivery, and placental MRI revealed that a transverse fundal incision could be made during CS. PPP was defined as the placenta broadly covering the entire anterior uterine wall, and sometimes placenta accreta could not be ruled out by grayscale and color Doppler ultrasonography and MRI. (2) Planned PTUI CS was

performed successfully. Any cases without sufficient data or CS with only one incision at the fundus were excluded. Anesthesia management and PBM records were reviewed retrospectively, and data regarding maternal and neonatal characteristics were collected.

Procedures

All patients were divided into two groups according to whether bilateral IIA BO catheters were placed. Consent for the prophylactic IIA BO catheters were obtained from all patients preoperatively during counseling. Some patients agreed after counseling, but not all. The group with a prophylactic IIA BO was named the IIA group, and the group without a prophylactic IIA BO was named control group. All patients underwent planned PTUI CS during hospitalization. On the day of delivery, the patients in the IIA group were transferred to the interventional radiology suite, and the prophylactic IIA BO catheters were placed. Then, the patients were transferred to operating room for the PTUI CS. No prophylactic IIA BO needed to be placed before operation in the control group.

PTUI CS

Recommend PTUI CS was performed under general anesthesia in any patient in whom the obstetrician made the diagnosis of PPP and PA. The PTUI technique comprised two incisions and two temporary ligations of the uterus. The first, transverse fundal incision was made near the uterine fundus and above the upper border of the placenta, without cutting through the placenta. The newborn was delivered safely and smoothly through this incision, which was then sutured rapidly. A rubber tourniquet was passed below the cervix and uterine body under the first fundus incision and ligated tightly. A second, transverse uterine incision was then made in the lower segment of the uterus, followed by manual removal of the placenta under direct observation. The new PTUI CS technique could result in minimal bleeding from the first transverse fundal incision, while any bleeding that did occur was easily controlled under direct observation.

Cell salvage

All study participants were provided with antenatal information about the cell salvage and gave informed consent before PTUI CS. Salvage equipment was set up at the outset of PTUI CS, and shed blood was collected and mixed with an anticoagulant from the surgical field after delivery of the baby. The RBCs were washed using intravenous saline 0.9% and then pumped into a bag for re-infusion to the same patient. Donor blood transfusion or salvaged blood returned for re-infusion was performed if deemed necessary by the anesthesiologist [29].

Outcomes

All outcomes were obtained retrospectively by review of the electronic medical records. The primary outcome was a composite measure of the total estimated blood loss (EBL), the proportion of patients receiving donor blood transfusion or cell salvage to manage hemorrhage and its consequences, the units

of donor blood transfused or salvaged blood returned, the rate and units of FFP transfused, and pre- and postoperative serum hemoglobin (Hb) and hematocrit (HCT). EBL during operation was measured by weighing compresses and blood collected by suction apparatus from the operation area caught in a measuring container.

Secondary outcomes were operation duration, hysterectomy rate, tubal ligation. Maternal demographic and obstetric characteristics were obtained: age, weight, gravidity, parity, prior cesarean delivery times, and gestational weeks. Neonate characteristics, including weight at birth and Apgar scores at 1, 5, and 10 min, were also collected.

We retrieved further information regarding of anesthesia management during the PTUI CS. Blood pressure, heart rate and other hemodynamic data during PTUI CS were collected. Data on mode of delivery, operation time, and median interval from peritoneal incision to delivery were collected.

Analysis

Data were analyzed using IBM SPSS version 22.0.0 for Windows (IBM Corporation. US). Demographic data and baseline clinical characteristics were tabulated and compared between groups. Non-parametric equivalents are presented with their medians and interquartile ranges (IQR). Continuous parametric data are presented with their means and standard deviations (SD). Categorical data are presented as counts and percentages. A P-value of 0.05 or less was considered statistically significant.

Results

Study population

Between 1 October 2016 and 31 October 2018, a total of 382 cases were reviewed retrospectively. After exclusion for eligibility, 64 patients were included in the analysis performed by anesthesiologists. Of these, 34 patients underwent prophylactic IIA BO (IIA group), and 30 were treated without prophylactic IIA BO (control group). Maternal characteristics are presented in Table 1. Maternal age, body weight, gestational weeks, parity, gravidity, and history of previous caesarean delivery were not significantly different between the two groups. The results of clinical assessment of the neonates are shown in Table 2. Birth weight, Apgar scores and sex composition were similar between two groups. There were 14 boys and 20 girls in the IIA group and 17 boys and 13 girls in control group. Three neonates in the IIA group and one neonate in the control group had Apgar scores less than 7 (1 min) and required a short period of assisted ventilation with the onset of sustained respiration after 60 s. At 5 and 10 min, all neonates had an Apgar score more than 8. Some 85.3% (29/34) of women the IIA group and 76.7% (23/30) of the control group had had more than three pregnancies. Most of the patients in the two groups had a history of one or more cesarean sections.

Table 1. Characteristics of participants at baseline.

Parameter	IIA group (n=34)	Control group(n=30)	*P* value
Maternal age (years)	34.5 (5.0)	34.4(4.7)	0.937
Body weight, kg	66.9 (6.3)	67.5 (8.6)	0.754
Gestational weeks, (weeks)	36.0(0.8)	35.9 (1.0)	0.756
Gravidity(n)	4.1(1.5)	4.0(1.7)	0.892
Parity(n)			
1	0	0	
2	5 (14.7%)	7 (23.3%)	
3^{+}	29 (85.3%)	23 (76.7%)	0.378
Prior caesarean delivery (n)			
0	2 (5.9%)	2 (6.6%)	
1^{+}	32 (94.1%)	28 (93.3%)	0.897
PPP	100%	100%	

Data presented are n (%) or mean (SD); IIA = internal iliac artery; PPP= pernicious placenta previa

Table 2 Neonatal Characteristics and Apgar scores.

	IIA group (n=34)	Control group (n=30)	P value
Birth weight, g	2710(359)	2558(316)	0.079
Male,	14/34	17/30	
Female,	20/34	13/30	
Apgar score at 1 min			
10	20(58.8%)	18(60%)	
8-9	11(32.4%)	11(36.7%)	
<8	3(8.8%)	1 (3.3%)	
Apgar score at 5 min			
10	32(94.1%)	28(93.3%)	
8-9	2(5.9%)	2(6.7%)	
Apgar score at 10 min			
10	32(94.1%)	29(93.3%)	
8-9	2(5.9%)	1(3.3%)	

Data presented are n (%) or mean (SD); IIA = internal iliac artery (IIA)

Patient surgical characteristics are summarized in Table 3. PTUI CS was performed successfully under general anesthesia in all patients included. The operation time and peritoneal incision-to-delivery (P-D) times were not significantly different between the two groups. The P-D time was 8.1 4 min in the IIA group versus 9.3 4.2 min in the control group (P = 0.320). Four patients underwent hysterectomy in the end: 3 of 34 (8.8%) in the IIA group and 1 of 30 (3.3%) in the control group. Histopathological examination confirmed the diagnosis of placenta accreta in those 4 patients. Tubal ligation was identified in 20 of 34 (58.5%) in the IIA group and 21 of 30 (70%) in the control group.

Table 3. Patient Surgical and anesthesia Characteristics

Parameter	IIA group (n=34)	Control group (n=30)	*P* value
Operation time, min	140.4(42.3)	123.7(45.9)	0.136
P-D, sec	8.1(4)	9.3(4.2)	0.320
Tubal ligation	20	21	0.352
Balloon catheter occlusion	34	0	
PTUI CS	34	30	
Hysterectomy	3(8.8%)	1(3.3%)	0.615

Data presented are n (%) or mean (SD); IIA = internal iliac artery (IIA); P-D = median interval from peritoneal incision to delivery; PTUI= parallel transverse uterine incisions(PTUI); CS= cesarean section

Perioperative blood management procedures and outcomes are shown in Table 4. The estimated blood loss (EBL) was significantly higher in the IIA group compared to the control group (2883.5 ML in IIA group versus 1868.7 ML in control group, P=0.001). Overall, the donor blood transfusion rate was 23.5 % (8/34), averaging 4.2 U, in the IIA group versus 30 % (9/30), averaging 3.4 U, in the control group, which were similar. The FFP transfusion rate was 47 %, averaging 765.6 ml, in the IIA group versus 20 %, averaging 816.7 ml, in the control group, which were also similar. For 1 of the 34 (2.9%) patients in the IIA group and 3 of the 30 (10%) patients in the control group, the salvage machine was unavailable. There is no explanation in the record for why cell savage was not used. In the IIA group, 97.1% used cell savage and had salvaged blood returned, averaging 954.9 ml. In the control group, 90% had salvaged blood returned, averaging 617.9 ml. All the patients who had cell salvage were associated with leukocyte depletion filter use, and no serious adverse reactions were reported.

There were no differences between groups in preoperative Hb (113.4±14 in IIA group versus 108.8 ± 12.4 in control group, P=0.18) or HCT (33.7 ± 4.2 in IIA group versus 33.1 ± 3.2 in control group, P=0.519). A significant reduction in Hb (96.4±11.5 in IIA group versus 100.5 ±12.9 in control group, P= 0.185) and HCT ((28.9 ±3.3 in IIA group versus 30.5 ± 3.7 in control group, P= 0.079) on the first day after PTUI CS in was observed in each group.

Table 4 Summary of blood management procedures and outcomes

Parameter	IIA group (n=34)	Control (n=30)	*P* value
General anesthesia	34(100%)	30(100)	
The EBL, ml	2883.5(1281)	1868.7(907.5)	0.001
Transfusion			
Donor RBCs, n (%)	l8(23.5%)	9(30%)	0.064
Donor RBCs, U	4.2(2.9)	3.4(1.3)	0.453
Salvaged blood returned, n (%)	33 (97.1)	27 (90%)	0.244
Salvaged blood returned, ml	954.9511.3	617.9374.6	0.006
FFP, n (%)	16 (47%)	6 (20%)	0.023
FFP, ml	765.6(172.9)	816.7(160.2)	0.537
Preoperative Hb (g/l)	113.4(14)	108.8(12.4)	0.180
Postoperative Hb (g/l)	96.4(11.5)	100.5(12.9)	0.185
Preoperative HCT	33.7(4.2)	33.1(3.2)	0.519
Postoperative HCT	28.9(3.3)	30.5(3.7)	0.079

Data are n (%), mean (standard deviation), or median (interquartile range).Hb= hemoglobin; FFP = fresh frozen plasma; EBL= estimated blood loss, RBC= red blood cells

Discussion

This retrospective cohort study showed that the use of prophylactic internal iliac artery balloon occlusion does not lead to a statistically significant reduction in the EBL or rate of hysterectomy in women with PPP and PA during PTUI CS. Cell salvage was associated with a reduction in the rate of donor blood transfusion during PTUI CS, and no cases of amniotic fluid embolism were observed because of the use of leukocyte depletion filters.

PPP and PA are the main cause of severe obstetric postpartum hemorrhage [13-15] and hysterectomy [16-17] and often require allogeneic blood transfusion [18]. Efficient hemostatic techniques should be performed to prevent PPH and preserve the uterus before, during and after CS. At present, there are many obstetric hemostatic techniques, such as abdominal aorta [19] or pelvic artery balloon occlusion [20-21], cell salvage [22], and modified surgical procedure [5,23]. BO (abdominal aorta or IIA) is the only technique that can be employed before CS in patients who need to keep the uterus and reserve fertility. The use of endovascular interventional procedures with BO has been described in the management of obstetric hemorrhage of various causes [24-25], but the effect of intraoperative IIA BO in women with PPP and PA is still controversial. Some authors advocate the use of IIA BO for treatment of PA, and they found

preoperative prophylactic BO was associated with reduced EBL and fewer massive donor transfusions [26]. However, other studies have found the opposite [27]. These studies have focused on the use of BO in traditional CS, and there are no reports on the preoperative application of BO during PTUI CS. In the study by Yong You et al, a novel technique using PTUI during CS is presented that could effectively control bleeding and preserve the uterus in patients with placenta previa and placenta accreta [5]. Prophylactic internal IIA BO and cell salvage are increasingly being performed during PTUI CS when there is a high risk of hemorrhage in our hospital. To our knowledge, this is first report about efficacy of IIA BO on reducing EBL during PTUI CS.

In our report, 34 patients with PPP and PA underwent prophylactic IIA BO during PTUI CS, and 30 did not. The EBL was significantly higher in the IIA group compared to the control group (2883.5 ML in IIA group versus 1868.7 ML in control group, P=0.001). In patients without IIA OB, the average bleeding during PTUI CS surgery was only 1868.7 ml. This amount of bleeding is not a life-threating event for high-risk patients with PPP and PA if treated correctly. This result is consistent with published results regarding the reduction of intraoperative EBL in PTUI CS [5]. Although the difference in the rate of hysterectomy between the two groups was not statistically significant, 8.8% (3/34) patients in the IIA group and 3.3% (1/30) of patients in the control group received final hysterectomy. Histopathological examination confirmed the diagnosis of severe PA in those 4 patients. These results suggest that when PTUI CS is performed without IIA BO, the rate of hysterectomy is very low. Hysterectomy cannot be completely avoided when PTUI CS is combined with IIA BO. In addition to the mode of PTUI CS, the occurrence of hysterectomy is closely related to the severity of placental implantation. Our findings suggest that PTUI CS may be an effective method to reduce the intraoperative EBL in patients with PPP and PA but does not completely eliminate the risk of hysterectomy.

Our findings concerning the effectiveness of IIA BO show that prophylactic IIA BO during PTUI CS did not lead to a statistically significant reduction in the EBL. There are three possible reasons for these findings. First, the obstetricians in the IIA group and those in the control group included for analysis were not the same surgical team. All PTUI CS were not performed by the same surgical team. In the IIA group, 17 of 34 PTUI CS were performed by the same surgical team, while in the control group, 22 of 30 PTUI CS were performed by the same surgical team. Technical differences may be one reason for the difference in EBL. Second, by the analysis of the clinical data of cases of EBL more than 4000 ml, we found that there were 8 cases of EBL more than 4000 ml in the IIA group, while there was none in the control group. In 5 of those eight cases, the PTUI procedure was slightly different. The placenta was delivered directly from the first transverse incision at the uterine fundus after the delivery of the fetus. During the delivery of the placenta, increased bleeding was found. Then, a second incision was made in the lower uterine segment to control the bleeding under direct vision. In the remaining cases, the standard PTUI CS, which comprised two incisions and two temporary ligations of the uterus, was used. The newborn was delivered safely and smoothly through the first incision, which was then sutured rapidly. A rubber tourniquet was passed below the cervix and uterine body under the first fundus incision and ligated tightly. A second, transverse uterine incision was then made in the lower segment of the uterus, followed by manual removal of the

placenta under direct observation. This slight difference in the procedure may be one reason for the difference in the outcome. Third, 5 of those eight patients with the EBL more than 4000 ml were diagnosed with severe PA in the lower uterine segment. Severity of PA may have contributed to the difference in the outcome.

No procedure is without complications. Although rare, prophylactic IIA BO has associated complications [28]. Placement of the IIA balloon catheter before CS might expose the fetus to some dose of radiation, although it has been reported that the dose is in the safe range. In addition, BO of IIA has been reported to cause complications, including maternal thromboembolic events, acute limb ischemia and ischemia–reperfusion injury, arterial pseudoaneurysms, and even arterial rupture. Puncture site complications, such as hematoma, false aneurysms and dissection of femoral arteries, may occur. In our opinion, during PTUI CS in the patients with PPP and PA, IIA BO should not be recommended because of its inefficiency and complications.

Our findings concerning the safety and effectiveness of cell salvage in PTUI CS shows that cell salvage may reduce the requirement for and amount of donor blood transfusion and maintains the postoperative hemoglobin concentration. PTUI CS in the IIA group was associated with higher EBL, and in these cases, cell salvage was routinely used. In the IIA group, the average estimated blood loss was up to 2883 ml. Although 33% had donor transfusion, the requirement for allogeneic blood was only 4.2 U on average, and the HB on the first day after surgery was 9.6 g. Some 41.2% (14/34) patient in IIA group had more than 1000 ml salvaged blood returned. Among them, the highest volume of salvaged blood returned was 2700 ml. These results suggest that the need for allogeneic blood may decrease because of the deployment of cell salvage. The use of cell savage during traditional CS has been reported in the management of obstetric hemorrhage of various causes. Some reported that preoperative routine use of cell salvage has not been associated with the overall reduction of donor blood transfusion during CS [29]. One possible reason for these different findings is that patients included for analysis in our study may have been different from those included in Khan KS et al.'s study [29], making the aims of the two studies different. In our study, suspected diagnosis with PPP and PA were confirmed by MRI before planned PTUI CS, and planned PTUI CS was performed successfully in all cases. In contrast, Khan KS et al. [29] included participants with an identifiable increased risk of hemorrhage, including placentation (abnormal versus normal multiple birth, and delivery by emergency or traditional elective CS. Further multicenter randomized controlled trials are needed to investigate whether cell salvage is beneficial for reducing intraoperative use for allogeneic blood in women with PPP and PA during PTUI CS.

leukocyte depletion filter is use for all the patients who received cell salvage, and no serious adverse reactions, such as amniotic fluid embolism, were reported in the records. Our results suggest that cell salvage is a relatively simple and effective blood conservation technique and may be beneficial for patient blood management during PTUI CS. This study suggests that concerns about the risk of amniotic fluid embolism should not be contraindication to its use during PTUI CS in a patient with PPP and PA. If cell salvage is to be used, employment of leukocyte depletion filters should be considered to reduce the risk of adverse reactions. Further research on the safety and effectiveness of cell salvage during PTUI CS

in high-risk patients, particularly in hospitals with a limited supply of donor blood for transfusion, will be useful in guiding decision-making.

While the PTUI CS procedure has become established in our department, we are aware that the PTUI CS is controversial, and further research in PTUI CS is necessary. Although a randomized controlled study of the management of PTUI CS procedure and IIA OB would yield the best scientific results, it is unlikely to performed a randomized controlled study because of its relative rarity and the ethical issues of such a study.

The purposes of PTUI CS are to reduce intraoperative bleeding, to ensure the safety of the mother, and to preserve the uterus. Patients included in our study had 2 incisions in the uterine body and lower uterine segment respectively. The main concern regarding PTUI CS procedure is the potential risk of uterine rupture during subsequent pregnancy. To prevent the unknown risk of uterine rupture during a subsequent pregnancy, 58.8% (20/34) patients in the IIA group and 66.6% in the control group had bilateral tubal ligation.

Our study had some limitations. First, it was a retrospective study, not a multicenter randomized controlled trial. Whether an IIA BO catheter was placed, for mostly clinical reasons, were chosen based on the obstetrician's discretion. Potential variations existed in the PTUI CS method, and what surgical techniques of PTUI CS were performed. In a few cases, the placenta was removed and bleeding was found, and then a second incision was performed in the lower uterine segment to stop bleeding under direct vision. A potential indication bias may also have existed. However, all patients included in our research had been diagnosed with PPP and PA by MRI before PTUI CS. The diseases, PPP and PA, included in our study were consistent in different group. Most patients retrospectively reviewed were only from the West China Second University Hospital of Sichuan University. A study of different regions and different races with larger sample size is necessary. Second, all PTUI CS were not performed by the same obstetrician team. Differences in PTUI CS techniques between obstetricians might have led to bias in the study. However, the majority of the patients in both groups were treated by the same obstetrician team (17/34 in IIA group versus 22/30 in control group). PTUI CS has become established in our hospital, but we are aware that PTUI CS with or without IIA BO is controversial, and further research in PTUI CS is necessary. A multicenter randomized controlled trial is required before PTUI CS can be performed into routine clinical obstetrical practice.

Conclusion

PPH is the largest contributor to maternal mortality worldwide. Skilled multidisciplinary care is required before, during, and after childbirth to prevent PPH as far as possible. This retrospective cohort study showed that the use of prophylactic IIA BO does not lead to a statistically significant reduction in the EBL or the incidence of hysterectomy in women with PPP and PA during PTUI CS. Cell salvage was associated with a reduction in the rate of donor blood transfusion during PTUI CS, and in our study, no cases of amniotic fluid embolism were observed with leukocyte depletion filters.

Abbreviations

PPP: pernicious placenta previa; PPH: postpartum hemorrhage; IIA: internal iliac artery; BO: balloon occlusion; PTUI: parallel transverse uterine incision; CS: cesarean section; EBL: estimated blood loss; FFP: fresh frozen plasma; Hb: hemoglobin; HCT: hematocrit; PA: placenta accrete; P-D: incision-to-delivery; CS = cesarean section, RBC: red blood cell

Declarations

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Availability of data and materials

The dataset used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors'Contributions

All authors are accountable for all aspects of the accuracy and integrity of the manuscript in accordance with ICMJE criteria and provided their consent for publication. Yushan Ma and Xi Luo designed and planned the study, analyzed the data, wrote the paper. Xuemei Lin and Xiaoqin Jiang designed and planned the study, revised the manuscript. Hui Liu and Lan Wu recruited patients from hospital database. All authors have read and approved the final manuscript.

Ethics approval and consent to participate

This retrospective study was approved by the Ethics Committee of the West China Second University Hospital of Sichuan University (No. 041/2018) and registered at the Chinese clinical trial registry (No. ChiCTR1900020774). Verbal consents to participate are obtained from all the patients. It is a retrospective study, and all data was anonymized, and this study does not contain any individual person's data in any form (including individual details, images or videos). Therefore, the Ethics Committee of the West China Second University Hospital of Sichuan University approved this procedure.

Consent for publication

All data was anonymized, and this study does not contain any individual person's data in any form (including individual details, images or videos). Therefore, consent for publication was approved.

Competing interests

The authors declare that they have no competing interests

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