

A Seven-Step Approach to Control Severe Hemorrhage in Cesarean Delivery with the Placenta Accreta Spectrum Disorders Avoiding Hysterectomy

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Abstract

Objectives: To describe a novel procedure to treat hemorrhage of placenta accreta spectrum disorders (PAS) or cesarean-scar pregnancy (CSP). **Methods:** This was a retrospective study of women under cesarean delivery with PAS or placenta previa. Patients' information was acquired from hospital records. A novel procedure of surgery is developed with seven major steps, including avoiding placenta incised, elevating upward the uterine, clamping the uterine arteries with sponge forceps, removing the placenta, opening the vesicouterine space and suture techniques. **Results:** A total of 38 patients were reviewed. Twenty-one patients diagnosed with placenta accrete syndrome and 3 patients with CSP were underwent surgery with the novel procedure of surgery and all severe hemorrhage was controlled without hysterectomy. There were 2 women with bladder injuries needing primary repair. Fourteen patients with placenta previa underwent cesarean delivery and there was no intraoperative complication of the total 14 patients. **Conclusion:** The seven-step approach is more secure and effective to control severe hemorrhage without other invasive procedures in cesarean delivery with PAS. It is technically easier to maintain and improve surgical skills.

Keywords

Placenta Accreta Spectrum, Placenta Previa, Cesarean, Postpartum

1. Introduction

There is a great risk of severe hemorrhage among women with PAS undergoing Cesarean deliveries, though surgery techniques and experiences improved.

There are a great many methods described to control hemorrhage, for instance, ascending branch of uterine artery, prophylactic infrarenal abdominal aorta or internal iliac artery balloon occlusion [1]-[11], many types of compression sutures and balloon tamponade [12]-[17], various lower uterine segment sutures [18]-[28], types of cervical internal os plasty [29] [30], even leaving the placenta in situ [31]. And there are also some procedures described to reduce the blood loss [32] [33]. No matter which methods are used, an effective suture must be used after them.

We should find an appropriate method to control hemorrhage. The method should be simple and easy to learn because women are not exactly diagnosed before surgery and serious hemorrhage occurred during the surgery in the primary hospital. In this article, we describe a novel procedure with common surgical skills to treat hemorrhage of PAS or CSP instead of technically surgical sutures.

2. Methods

This was a retrospective study of women under cesarean delivery with PAS or placenta previa at Department of Obstetrics and Gynecology, Qilu Hospital, Shandong University between January 2015 and November 2019. This study protocol was approved by the Ethics Committee of Qilu Hospital.

Patients' information was acquired from hospital records, including the demographic features, clinical findings and the methods of diagnosis and treatment. All of the patients were diagnosed by ultrasound and/or magnetic resonance imaging (MRI) and desired to preserve their fertility. The followed magnetic resonance imaging was also very helpful. Though most PAS normally started as PAS, there were still many women diagnosed with PAS without undergoing prior cesarean.

Preoperative preparation is a critical factor in achieving successful outcomes of both emergent and scheduled surgical procedures. Foremost, it is essential to keep communication with anesthetist and blood transfusion department. The surgeon must discuss the whole process with assistants, and make sure the assistants grasp how to do it in the operation. Before the operation, we usually use the visualization and mental imagery rehearsal to help the surgeon and assistant to get familiar with the operation and then the actual performance immediately follows the imagery session by reviewing details of an entire surgical procedure with the appropriate hand movements for the operation.

The puncture of the distal radial artery and placement of central venous access was very helpful in the operation. Indications for them include access to administration of drugs or haemodynamic monitoring and interventions, especially for the blood transfusion.

The estimation of blood loss is the most important things during the surgery. The suction instrument of blood collection system was applied to collect the blood from the abdominal cavity and measure the blood loss through the suction bottle. All the gauze or pads with blood from the wound and the gynecological drape with blood from the vagina were collected, weighed and an equivalent volume was calculated. The total blood loss during the operation was estimated by the surgeon, nurse and the anesthetist.

The procedure of cesarean delivery of the women with placenta previa was similar to normal cesarean delivery. Treatments such as manual massage, uterotonic agents and under-sewing the bleeding points with a figure-eight suture were performed in the surgery and all the bleeding was successfully controlled.

The novel procedure was developed from seven-step approach.

The first step: avoiding the placenta incised in uterine incision

The purpose is mainly to reduce blood loss of uterus and fetus. Planned hysterotomy site should be chosen by ultrasound or the surgeon's examination to try to avoid the placenta incised. The transverse incision is still preferred, though most incisions are not performed at the lower uterine segment.

The second, third and fourth step: elevating upward the uterine after delivery of fetus, grasping the lower uterine segment and clamping the uterine arteries with sponge forceps.

These three steps are used to control the initial hemorrhage. The uterus with placenta left undisturbed in situ should be quickly elevated upward out of the abdominopelvic cavity and the lower uterine segment was grasped tightly with a hand (the second and third steps). The severe hemorrhage must be controlled. And then angled away from the targeted uterine artery, Pennington or sponge forceps can be applied for hemostasis. With sponge forceps, the targeted uterine artery is clamped and ligated. The oviduct, round ligament, medial mesosalpinx and broad ligament are hold by the sponge forceps to ligate the tubal branch of uterine artery and Sampson's artery to round ligament. The clamps are placed as close as to the uterine as possible taking care not to include excessive tissue in each clamp. And the clamps must be placed at the level of the cervix (the fourth step) (**Figure 1**). The procedure is repeated on the other side.

The fifth step: removing the placenta manually and control the vigorously bleeding.

Placental delivery needs the urgent help to aid placental separation. Placenta must be removed immediately by surgeon's finger or sponge forceps. In either situation, if the incision is still bleeding appreciably, sponge forceps can be applied for hemostasis. The lower uterine segment especially below the uterine incision is observed for any vigorously bleeding sites. These should be promptly clamped with sponge forceps. And the clamps are placed at the level of the

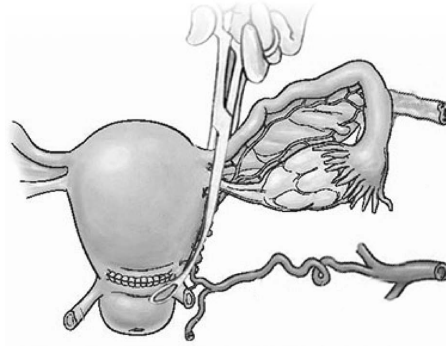


Figure 1. The fourth step of seven-step approach. Pennington or sponge forceps are applied for hemostasis. The oviduct, round ligament, medial mesosalpinx and broad ligament are held by the sponge forceps to ligate the uterine artery, the tubal branch of uterine artery and Sampson's artery to round ligament. The clamp is placed as close as to the uterine as possible taking care not to include excessive tissue in each clamp. And the clamp must be placed at the level of the cervix.

internal os. It may be more advantageous in case of profuse hemorrhage to rapidly double clamp and divide all of the vascular pedicles between clamps to gain hemostasis. The excessive bleeding should be control.

The sixth step: opening the vesicouterine space from unilateral paravesical space.

The vesicouterine space is opened with Metzenbaum scissors held perpendicular to the cervix in the midline. This space is further defined and stretched by gentle dissection with the index finger. But in these cases, the opening of the vesicouterine space may be particularly difficult because of adhesion. Even though more careful sharp dissection is performed, laceration of the bladder is more common and carries a risk of damage to the bladder. We usually open the vesicouterine space from the right or left paravesical space toward the midline due to the paravesical space is rare adhesion. In practice, once unilateral paravesical space is clearly identified, we usually started suturing. When the whole vesicouterine space was opened and the suture of the lower uterine segment was finished.

The seventh step: suturing from the level of the internal os with figure-of-eight and interrupted suture techniques.

This step is the critical and essential procedure to completely control hemorrhage. Suture ligated is still the initial and important method. The figure-of-eight and interrupted suture techniques are strongly considered. All the sutures are used to enter and exit the uterine cavity laterally in the uterine segment. The initial stitch is taken just slightly beyond the internal os by figure-of-eight or interrupted suture techniques. Index and middle fingers are placed in the lower uterine cavity and against the lower uterine segment in case of suturing the lower posterior uterine segment (**Figure 2**). And then, the suture continued upward until approaching the edge of uterine incision. It is important to carefully select the site of each stitch and to avoid too many sutures. Suture should be placed as little as possible to achieve approximation and hemostasis.

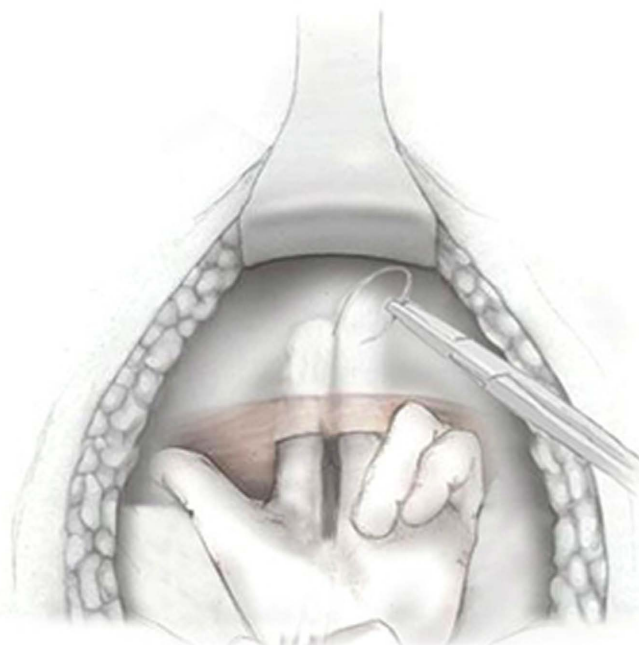


Figure 2. The seventh step of seven-step approach. The initial stitch is taken just slightly beyond the internal os by figure-of-eight or interrupted suture techniques. Index and middle fingers are placed in the lower uterine cavity and against the lower uterine segment in case of suturing the lower posterior uterine segment. In practice, once unilateral paravesical space is clearly identified, the suture is starting.

3. Results

A total of 38 patients were reviewed. There were 21 patients diagnosed with placenta accrete syndrome and 3 patients with CSP. Fourteen patients were diagnosed with placenta previa.

The 21 patients diagnosed with placenta accrete syndrome and 3 patients with CSP were underwent surgery with the novel procedure of surgery. Participant characteristics are shown in **Table 1**. The median age was 33.25 years (range 24 to 40 years). The gestational age at delivery ranged from 13 to 38 + 5 weeks. Before the last cesarean, 8 women had suffered twice cesarean delivery, 11 women had suffered cesarean delivery once. There were 5 women without cesarean delivery. The median estimated blood loss was 2462.5 ml (range 1000 to 5500 ml). The median operation time was 98.9 minutes (range 52 to 190 mins). There were 2 women with bladder injury needing primary repair.

The total of 14 patients with placenta previa underwent cesarean delivery. Participant characteristics are shown in **Table 2**. The median age was 33.1 years (range 28 to 46 years). The gestational age at delivery ranged from 31 + 3 to 38 + 4 weeks. Before the last cesarean, 2 women had suffered twice cesarean delivery, 11 women had suffered cesarean delivery once. There was only one woman without cesarean delivery. The median estimated blood loss was 564.3 ml (range 300 to 800 ml). The median operation time was 70.8 minutes (range 50 to 140 mins). There was no intraoperative complication of the total 14 patients.

Table 1. The characteristics of participants and description of materials in the PAS and CSP.

Case no.	Maternal age (years)	Gestation age (weeks)	Gravidity & parity	Presenting diagnosis	Number of prior cesarean	Estimated blood loss (ml)	Operation time (mins)	Intraoperative complications (Y/N)
1	34	34 + 6	G4P3A1L3	PAS	2	4500	157	N
2	25	17	G3P1A2L1	CSP	1	3000	105	N
3	28	38 + 1	G3P2A1L2	PAS	1	4500	175	N
4	24	13	G2P1A1L1	CSP	1	2000	100	N
5	38	36 + 1	G3P2A1L2	PAS	0	1500	65	N
6	40	38 + 1	G4P2A2L2	PAS	1	2200	80	N
7	33	31 + 1	G2P2A0L3	PAS	0	1500	57	N
8	34	37 + 6	G3P2A1L2	PAS	0	2000	60	N
9	35	34 + 1	G3P2A1L2	PAS	1	5500	120	N
10	28	37 + 2	G2P1A1L1	PAS	0	1200	52	N
11	32	38 + 5	G6P3A3L3	PAS	2	1500	95	N
12	32	37	G4P2A2L2	PAS	0	1300	55	N
13	37	23	G4P2A2L2	CSP	2	5000	115	N
14	34	34 + 4	G4P2A2L2	PAS	1	2000	75	N
15	28	36 + 2	G3P2A1L2	PAS	1	1200	90	N
16	39	37 + 4	G2P2A0L2	PAS	1	3000	190	N
17	34	35 + 5	G5P3A2L3	PAS	2	3500	104	N
18	34	34 + 6	G4P2A2L2	PAS	1	1000	65	N
19	37	38 + 5	G3P2A1L2	PAS	1	1000	85	N
20	39	38 + 1	G4P3A1L3	PAS	2	1200	68	N
21	37	37 + 5	G4P3A1L2	PAS	2	1000	85	N
22	40	37 + 5	G4P3A2L3	PAS	2	1000	80	N
23	29	37 + 1	G3P2A1L2	PAS	1	4500	180	Y (Bladder injury)
24	27	36 + 2	G5P3A2L3	PAS	2	4000	117	Y (Bladder injury)

Table 2. The characteristics of participants and description of materials in the placenta previa.

Case no.	Maternal age (years)	Gestation age (weeks)	Gravidity & parity	Number of prior cesarean	Estimated blood loss (ml)	Operation time (mins)	Intraoperative complications (Y/N)
1	29	34 + 1	G3P2A1L2	1	700	53	N
2	46	35 + 4	G4P3A1L3	1	700	72	N
3	31	38	G5P2A3L2	1	300	62	N
4	29	34 + 6	G4P2A2L2	1	400	70	N
5	30	37 + 1	G3P2A1L2	1	800	70	N
6	29	36	G8P3A5L3	2	300	50	N

Continued

7	39	35 + 5	G8P2A6L2	1	800	55	N
8	35	36 + 6	G4P2A2L2	0	400	75	N
9	28	31 + 3	G3P2A1L2	1	600	60	N
10	31	36 + 3	G3P3A0L3	2	400	62	N
11	34	35 + 1	G4P3A1L2	1	800	140	N
12	31	38 + 4	G3P2A1L2	1	600	92	N
13	34	33 + 1	G4P2A2L2	1	500	75	N
14	37	35 + 1	G3P2A1L2	1	600	55	N

4. Discussion

With the widespread use of ultrasound in obstetric, the women with PAS or CSP were suspected or diagnosed earlier than before. Most of the patients undergo a scheduled surgical procedure, but it is still very difficult to accurately evaluate the blood loss before the cesarean. In this study, we found that the blood loss rised linearly when it was more than 3000 ml in an operation. It reveals that we meet the severest hemorrhage and the forecast of blood loss will be more difficult. The blood loss extends the operation time. If the blood loss is no more than 2500 ml, blood loss and operating time are forecast. But once the blood loss is more than 2500 ml, it indicated that the unusually severe hemorrhage occurred ant it was very difficult to control (**Figure 3**). We think that those patients may be with the mild PAS which with the blood loss less than 2500 ml. But we must make a more detailed plan to control hemorrhage with every patient. Even so, the blood loss of a patient with CSP under a perfect preparation is 3000 ml (**Figure 4**).

According to purpose of the methods for controlling the hemorrhage, we may divide the procedure into 2 stages. The first stage is immediately controlling the hemorrhage including all types of the artery ligation balloon occlusion from the uterine incision to the placenta removal and the second stage is the completely controlling the hemorrhage including all types of the sutures from the opening the vesicouterine space and suture to completely control the hemorrhage. The simple seven-step approach is a perfect match with the 2 stages.

For most normal cesarean deliveries, the transverse incision within the lower segment is preferred. In those cases, because the placenta usually places at the lower uterine segment, serious hemorrhage must suddenly occurs due to the lower uterine segment incision encountering the placenta. Hysterotomy placement must be modified to keep the incision centered without the placenta. The use of a linear cutter and the Triple-P procedure were described to reduce blood loss [32] [33]. The planned hysterotomy site of these 2 techniques is chosen out of the lower uterine segment. In our study, all the uterine must be incised in the planned hysterotomy site without the placenta (**Figure 5**), though the placenta may be still encountered in the incision line. It significantly reduces the blood loss of uterine and fetus.

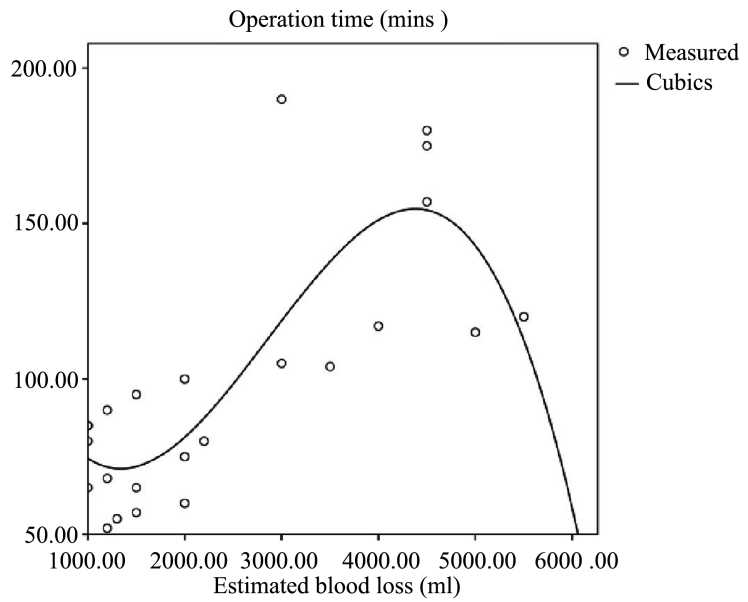


Figure 3. The cubics function shows that once the blood loss is more than 2500 ml, it indicated that the unusually severe hemorrhage occurred and it was very difficult to control.

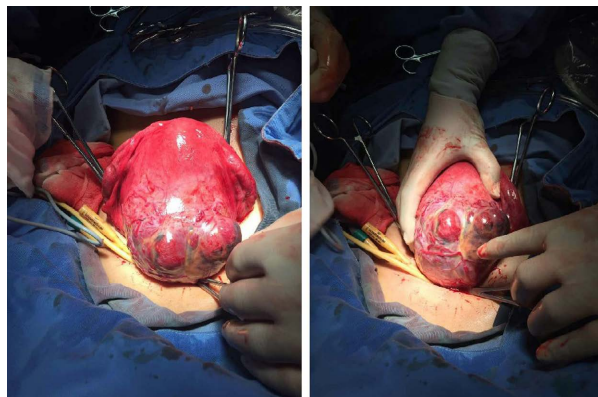
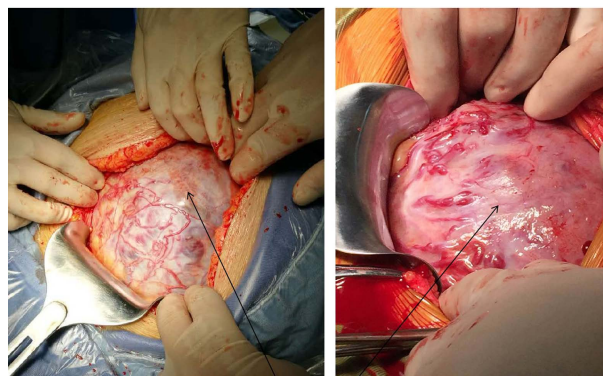


Figure 4. In this case, even with sufficient preparation, the blood loss of this CSP is still 3000 ml.



planned hysterothomy site

Figure 5. Though the planned hysterothomy site is not at the lower uterine segment and the incision is very thick, we still choose it. And the blood loss of uterus and fetus is reduced significantly.

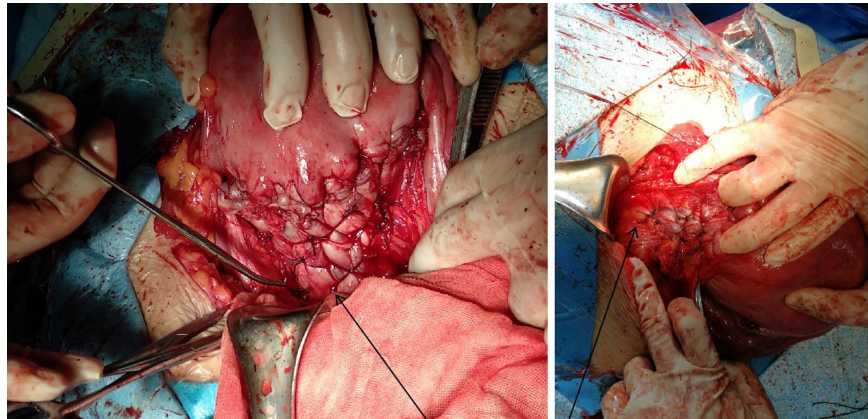
The plan serious hemorrhage must suddenly complicate operative procedure after delivery of the fetus. The excessive bleeding quickly adds up to a significant amount of blood loss. It must be controlled.

The ascending branch of uterine artery and balloon occlusion were used frequently, especially the use of prophylactic infrarenal abdominal aorta or internal iliac artery balloon occlusion. Though some types of techniques were described to control the hemorrhage by artery ligation, the details were not provided [32] [33]. According to many reports, the use of prophylactic infrarenal abdominal aorta or internal iliac artery balloon occlusion has been proposed for reducing and controlling the hemorrhage [1]-[10]. But a latest randomized controlled trial found that the use of prophylactic internal iliac artery balloon occlusion in placenta previa patients undergoing cesarean delivery did not reduce postpartum hemorrhage [11]. In addition, because of the merit and demerit of occlusion site, Shigeki Matsubara et al thought that it was the time to widely discuss “aortic balloon occlusion where?” The choice of the aorta-occlusion site may depend on the balance between controlling hemorrhage and reducing the ischemic renal damage [34].

In our study, the second, third and fourth steps of the simple seven-step approach are used to control the initial hemorrhage. It is also artery occlusion and it is more effective, less technically demanding, higher degree of pelvic devascularization, minor injury and repeatability. Quickly elevating upward the uterus and grasping the lower uterine segment will control the hemorrhage in seconds. With the help of assistant, Pennington or sponge forceps must be applied to clamp the uterine arteries. All the blood supply to uterine including uterine arteries and collateral circulation is occluded. If the lower uterine segment especially below the uterine incision is observed for any vigorously bleeding sites after removing the placenta immediately by surgeon’s finger or sponge forceps, these should be promptly clamped with sponge forceps at the level of the internal os for hemostasis.

Because of the adhesion and PAS, the dissection of the bladder off the uterus to expose the lower uterine segment is very difficult and dangerous. But without the opening of the vesicouterine space, it is hardly to completely control the hemorrhage. It is reported that the vesicouterine space is opened after filling the bladder with 300 ml saline and the procedure may have some benefits including shorter operation time, lower amount of hemorrhage, and less bladder injury [35].

In this study, because the bladder flap is unusually adhered in the midline of the lower uterine segment in most cases, the opening of the vesicouterine space usually is from the right or left paravesical space toward the midline to avoid damage to the bladder due to the paravesical space is rare adhesion. Once the bladder and attached peritoneal flap is further deflected and dissected as needed from the lower uterine segment and retracted out of the operative field, it becomes easy to control hemorrhage.



initial stitch slightly beyond the internal os

Figure 6. The initial stitch is taken just slightly beyond the internal os by figure-of-eight or interrupted suture techniques. The suture continued upward until approaching the edge of uterine incision. Suture should be placed as little as possible to achieve approximation and hemostasis.

In all the cases, the initial and important method to completely control the bleeding is still suture ligated. The figure-of-eight and interrupted suture techniques are strongly considered. Though there are many types of sutures [18]-[28], all the techniques are more difficult than the figure-of-eight and interrupted sutures. And some sutures are not effective as figure-of-eight and interrupted sutures. The initial stitch must be taken just slightly beyond the internal os by figure-of-eight or interrupted suture techniques. Some reports also emphasize to suture from or around the internal os [29] [30]. It is important to carefully select the site of each stitch to avoid uterine necrosis because of too many sutures. Suture should be placed as little as possible to achieve approximation and hemostasis. In our study, we suture for hemostasis following these principles (**Figure 6**).

An absorbable suture ligated is also placed in the posterior uterus. The surgeon's index finger is placed in the posterior uterus. If the surgeon considered that there is thinner than others, it needs an absorbable figure-of-eight suture.

Though all the skills of the seven-step approach are common, it also requires surgeon and assistant's perfect cooperation and needs to maintain and improve the surgical skills. Before the surgery, the procedure is discussed between surgeon and assistant, including details of an entire surgical procedure, even how to correctly apply a clamp. The surgeon must make sure the assistants grasp how to do it in the operation. Though all the operations were performed by the authors, we still use visualization and mental imagery rehearsal to enhance the technical skills and increase emotional preparedness before every operation and performed perfectly.

5. Conclusion

In summary, we develop the seven-step approach to control hemorrhage and get

successful surgeries without hysterectomy. The novel procedure is helpful to control the severe hemorrhage of women without exact diagnosis before surgery and the serious hemorrhage that occurred during the surgery in the primary hospital. It is more secure and effective to control severe hemorrhage in cesarean delivery with the placenta accreta spectrum because of the common surgical skills and without other invasive procedures. The seven-step approach is also technically easier to maintain and improve surgical skills.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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