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Original Research

Barbed Suture versus Conventional Suture for Uterine Repair in Women with Placenta Accreta and Placenta Increta: A Retrospective Cohort Study

Ruihong Dong[1,2,3,†], Lin Zhang[1,2], Qian Chen[1,2], Qiuhe Chen[1,2], Yuxia Wu[1,2], Dan Shan[1,2,*,†], Yayi Hu[1,2,3,*,†]

[1]Department of Obstetrics and Gynecology, West China Second University Hospital, Sichuan University, 610041 Chengdu, Sichuan, China
[2]Key Laboratory of Birth Defects and Related Diseases of Women and Children, Sichuan University, Ministry of Education, 610041 Chengdu, Sichuan, China
[3]Qingbaijiang Women's and Children's Hospital, West China Second University Hospital, Sichuan University, 610041 Chengdu, Sichuan, China
*Correspondence: shandan_scu@outlook.com (Dan Shan); yayihuscu@sina.com (Yayi Hu)
[†]These authors contributed equally.

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Abstract

Background: Placenta accreta spectrum can cause catastrophic hemorrhage. Knotless barbed suture line has been considered to reduce bleeding during cesarean section (CS). The purpose of this study was to determine whether the use of knotless barbed suture line could effectively reduce bleeding in patients with placenta accreta and placenta increta. **Methods**: After obtaining ethical approval, we performed a retrospective cohort study between women with the barbed suture (n = 42) and no barbed suture (control, n = 42). In the barbed suture group, the bleeding site from the damaged myometrium layer caused by the placenta villous invasion was sutured by barbed line with a continuous running suture made in the myometrium layer. In the control group, the uterine incision was repaired with two layers of a continuous suture using the conventional polyglactin suture line. Primary outcomes were the blood loss during the CS and blood loss in the first 24 hours after surgery. **Results**: The total sample size was 84 (42 in the barbed suture group, another 42 in the control group). Blood loss during CS was significantly lower than the control group by an average of approximately 200 mL (848.57 $\pm$ 373.20 mL in the barbed suture group *vs.* 1055.95 $\pm$ 470.88 mL in the control group, $p = 0.028$). Blood loss during the first 24 hours was also diminished in the barbed suture group (42.70 $\pm$ 36.71 mL in the barbed suture group *vs.* 65.60 $\pm$ 61.44 mL in the control group, $p = 0.041$). **Conclusions**: The application of barbed suture line reduced blood loss both during CS and after 24 hours of CS.

Keywords: barbed suture; placenta accreta; placenta increta; postpartum hemorrhage

1. Introduction

Placenta accreta spectrum (PAS) can cause catastrophic hemorrhage during delivery. PAS is still one of the main contributors for severe postpartum hemorrhage (PPH) [1–3]. Initially described as the abnormal adhesion of the placenta to the myometrium in 1937, PAS was then recognized as a spectrum of abnormal placenta adherent and invasive disorders [4]. PAS is now graded depending on the depth of the villous penetration into the uterine myometrium layer, including placenta accreta, placenta increta, and placenta percreta [5]. As the cesarean section (CS) rates increased worldwide in recent decades, however, the incidence for PAS is on the rise. The prevalence of placenta previa was approximately 0.56% and the prevalence of placenta previa with PAS was 0.07% worldwide [6].

Scheduled cesarean hysterectomy is an option for women with intractable PPH, especially in patients with placenta percreta [1,7,8]. But in women of reproductive age, conservative managements including uterine compression suture methods, efficient uterotonics, uterine artery embolization and other pelvic devascularization methods are crutial [9]. Since B-Lynch first reported his brace suture method in 1997, this classical suture method has been widely praised [10]. More than 10 variants of uterine compression suture methods have been reported by then. But most of these surgical methods were targeted at atony of the uterine corpus. However, in patients with PAS, severe bleeding caused by the peeling surface in uterine myometrium layer after removal of placenta is not rare [11,12]. Especially the bleeding from uterine wall near the internal cervical orifice is usually hard to control. Except for Bakri balloon and intrauterine gauze packing, uterine artery embolization could be applied in certain hospitals. However, in a country like China, there is distinguishable differences of regional economic medical resources. Many primary hospitals lack these interventions. Homostatic sutures under direct vision during CS is still a preferred method for most obstetricians.

Barbed suture line has been in clinical use since the 1960s [13,14]. It has bidirectional barbs along its length that secure the suture and prevent slippage. The self-

anchor characteristic of this suture line has its unique advantages during surgery and have gained popularity in plastic surgery, wound closure and laparoscopic surgeries [15–17]. Barbed suture line had been used to close the uterine incision during CS in several studies [18–21]. Results from these studies proved the favorable effects [22]. However, there were no relevant studies exploring the role of knotless barbed suture line in placenta accreta and placenta increta. With these benefits in mind, we performed a retrospective cohort study/concurrent controlled trial to evaluate the efficacy and safety of barbed suture line for uterine repair during CS. The purpose of this study was to determine whether the use of knotless barbed suture line could effectively control bleeding in patients with placenta accreta and placenta increta.

2. Materials and Methods

This study was approved by the Ethics Committee of West China Second University Hospital of Sichuan University (Ethic approval number: 2020065). All methods were carried out in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Relevant clinical guidelines and regulations were followed. The study was conducted after providing necessary explanations and information to the participants. Written informed consent was obtained from all the participants. This study adheres to the Appraisal of Guidelines for Research & Evaluation (AGREE) guidelines. The inclusion criteria were women with singleton pregnancy who underwent selective cesarean (CS) section, and who were diagnosed with placenta increta and placenta accreta intraoperatively. Placenta accreta is like a 1st degree abnormal placental attachment. It occurs when the attachment of the placenta to the uterus is deeper than normal but not deep enough to actually penetrate the uterus muscle. Placenta increta is defined as a somewhat deeper (2nd degree) penetration of the placenta into the uterine wall. The wall of the uterus is almost fully penetrated but still falls short of attaching to the muscle [15]. Considering the potential catastrophic hemorrhage risk, we excluded patients diagnosed with placenta percreta. Women who received other hemostatic managements like hysterectomy, uterine compression sutures, application of Bakri balloon, internal iliac artery balloon occlusion, abdominal aorta balloon occlusion, or uterine artery embolization were excluded. Patients unable to give consent, with severe pregnancy related complications, or with abnormalities which could lead to coagulation disorders were excluded. Patients with severe systematic disease like liver, kidney or blood system disorders were excluded.

After the informed consent was obtained, the patients with suspection of placenta accreta and placenta increta who are willing to use the barbed suture line according to the intraoperative conditions were identified as the barbed-suture group (BS group), others who are unwilling to use the barbed suture line were identified as the control group.

The type of anesthesia was decided by the anesthesiologists who were unaware of the difference in suture groups. The CS was performed by the same attending physician and resident, who were aware of the nature of the study. After the Pfannenstiel incision in the abdomen, a standard lower uterine segment transverse incision was performed. In the control group, after the expulsion of placenta, oxytocin was used. The uterine incision was repaired with two layers of a continuous suture using the conventional polyglactin suture line. Uterine massage and uterotonics such as oxytocin, carbetocin, ergometrine or hemabate were applied if needed. The use of a uterotonic agent was based on the uterine contractions and oozing from the uterine cavity. In the BS group, the bleeding site from the damaged myometrium layer caused by the placenta villous invasion was sutured by barbed line (STRATAFIX^{TM} Spiral, ETHICON, Raritan, NJ, USA). A continuous running suture is made in the myometrium layer (Figs. 1,2). The chief surgeon makes sure the running suture surpassed the bleeding spot, the entry point and exit point was approximately 0.5 cm away from the bleeding site. The tension of the suture line was controlled by the chief surgeon. Careful inspection of the suture was executed by the surgical assistant to ensure that the bleeding site has been fully surpassed without penetration to the serosa layer (Figs. 3,4). Then, the uterine incision was repaired with the conventional suture line, uterotonics were applied as needed. If the above methods could not stop bleeding, other interventions including other uterine compression sutures, uterine Bakri balloon or uterine arterial embolization (UAE) were applied immediately. And the patient was excluded from the final analysis. All patients were followed up during their hospital stay and until 6 weeks after the operation. A specific surgery nurse who were blinded to the group difference recorded the time for operation and blood loss during surgery. When the patient was transferred to ward, the follow-up treatments and recording of vaginal bleeding were managed by medical staff who were blinded to the group difference.

Our primary outcomes included the blood loss during CS and blood loss in the first 24 hours after surgery. The amount of bleeding during CS was estimated subjectively by the attending surgeon taking into account of the amount of blood in the suction canister, postoperative gauze and laparotomy pads. A research nurse who were blind to the group difference recorded the blood loss. Contamination with amniotic fluid was avoided by quick suction when the amniotic sac was open. The laparotomy pads were weighed after surgery and the increase was defined as the amount of bleeding during surgery. The blood loss was also evaluated objectively by the change in hemoglobin between preoperative and postoperative blood count tests. Our secondary outcomes included (1) Total time duration of CS. Time from the start of Pfannenstiel incision until the attending surgeon

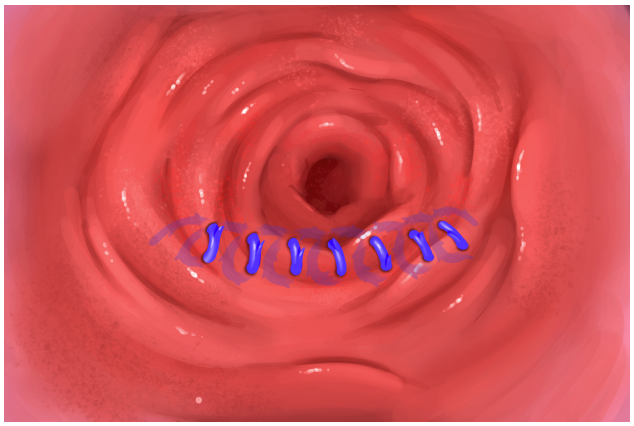

Fig. 1. Continuous running suture made in the myometrium layer.

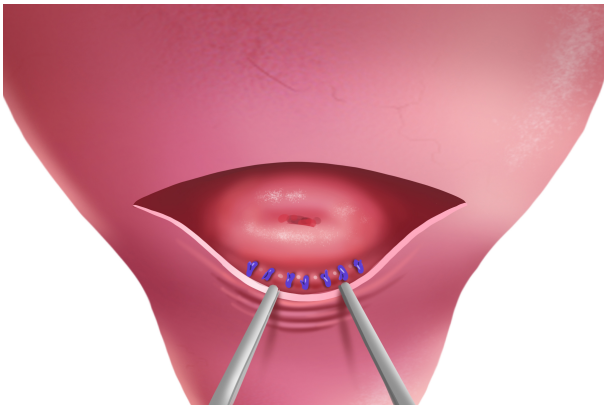

Fig. 2. Continuous running suture made in the myometrium layer from general view.

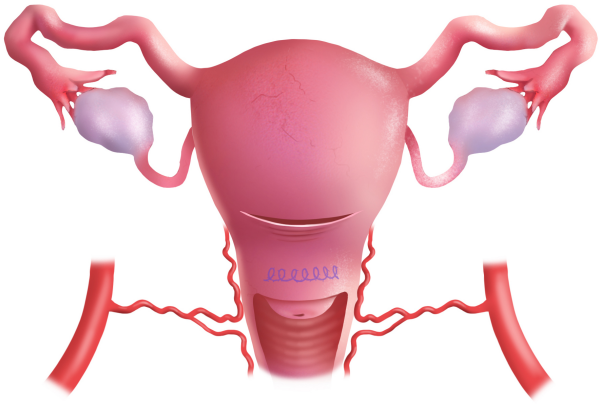

Fig. 3. Careful inspection of the suture from general view.

called the end of surgery was recorded by a surgical nurse. (2) Need for uterotonic agents used during CS and after CS (Potent uterotonic drugs included ergonovine and carboprost). (3) Serious maternal morbidity (e.g., admission to intensive care unit). (4) Need for blood transfusion. (5) Time for hospital stay of the patient after CS. (6) Puerperal status of the patients.

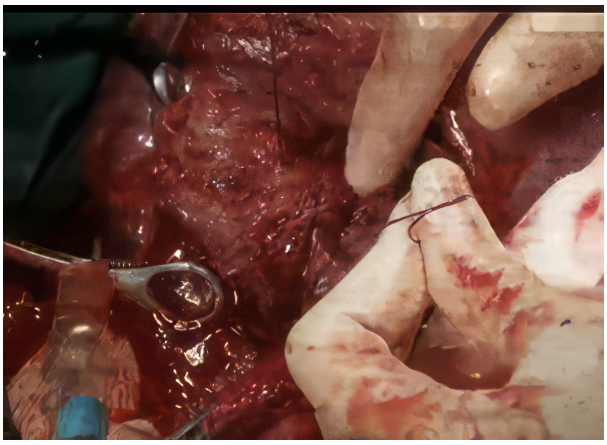

Fig. 4. Actual picture of suturing during surgery.

A pilot study was conducted to calculate the appropriate sample size. The pilot study included 20 consecutive pregnant women (10 participants each) with placenta previa undergoing lower segment cesarean section. The blood loss in the BS group was 864 $\pm$ 280 mL and 1085 $\pm$ 446 mL in the control group.

Using the observed difference in the blood loss during CS in the pilot study, power calculation indicated that a sample size of 42 patients was needed in each group if we want to detect the difference in blood loss between the two groups with an alpha of 0.05 and a power of 80%.

Statistical analysis was performed using SPSS software version 24 (IBM Corp., Armonk, NY, USA). Continuous variables with a normal distribution are presented as mean $\pm$ standard deviation (SD), whereas categorical variables were expressed as frequency, n (%), then a *t*-test or chi-square test was used to compare the clinical characteristics between the two groups, $p < 0.05$ was considered statistically significant.

3. Results

From November 2020 to May 2021, a total of 107 patients who were diagnosed with placenta accreta and placenta increta intraoperatively willing to give consent were included in this research. Twelve patients were excluded because of the application of other compression suture techniques. Five patients were excluded because of the application of Bakri balloon. Three patients were excluded because of the application of uterine cavity gauze packing. Three patients were excluded because of the application of uterine arterial embolization (Fig. 5). After exclusions, 42 eligible participants wiling to use the barbed suture line were included in the barbed suture group, another 42 patients who refused to use the barbed suture line were identified as the control group.

The demographical and clinical characteristics of the two groups were presented in Table 1. There were no statistically significant differences between the two groups.

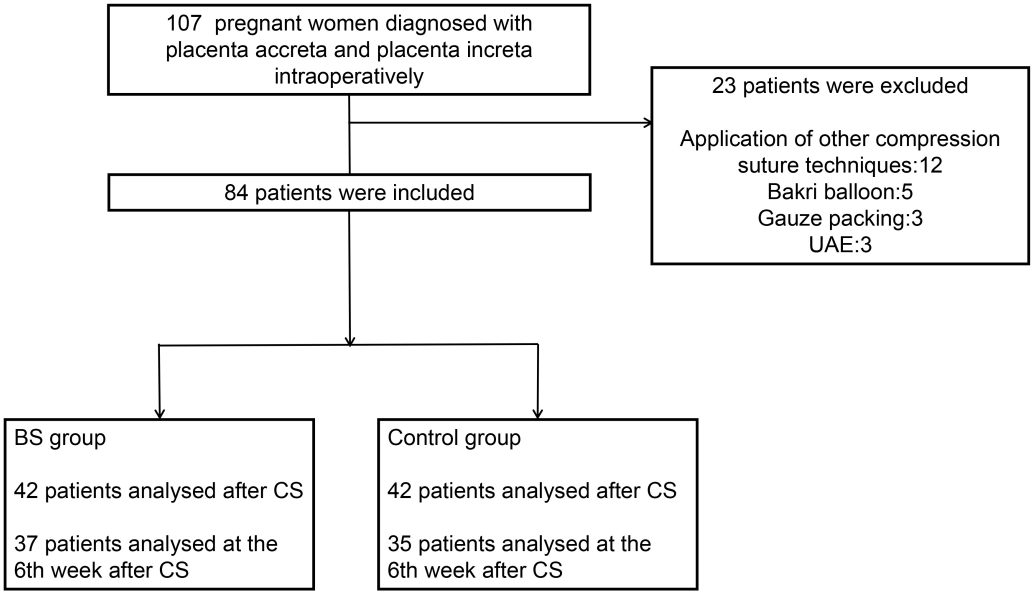

Fig. 5. Flowchart showing the number of included and excluded subjects. BS, barbed-suture; CS, cesarean section; UAE, uterine arterial embolization.

Blood loss during CS, the primary outcome of this study, was significantly lower than the control group by an average of approximately 200 mL (848.57 ± 373.20 mL in BS group *vs*. 1055.95 ± 470.88 mL in the control group) (Table 2). Blood loss during the first 24 hours was also diminished in the BS group. There was no difference in total operation time between the two groups (69.40 ± 10.05 min in the BS group *vs*. 67.95 ± 14.67 min in the control group). The rate for the requirement of repeated application of uterotonics during CS was lower in the BS group (40.48% in BS group *vs*. 61.90% in control group). Less patients required repeated application of uterotonics after CS in the BS group (7.14% in BS group *vs*. 16.67% in control group). There was no significant difference between the two groups in other parameters as puerperal morbidity and intensive care unit (ICU) admission rate. The newborn birthweight and Apgar score were comparable.

There were no complications specifically to the suture method. About 20% of participants in each group had fever after CS. If the body temperature exceeds 39 °C, blood culture was retrieved. But in all patients the blood culture was negative and the patients recovered well after prolonged antibiotics and physical hypothermia therapy. Autologous blood transfusion was given in 34 patients and allogeneic blood transfusion was given in 21 patients (6 patients in BS group and15 patients in control group, respectively). The amount of autologous blood transfusion was 169.81 ± 44.38 mL in BS group and 273.50 ± 68.00 mL in control group respectively. The amount of allogeneic blood transfusion was 154.76 ± 68.17 mL in BS group and 332.14 ± 90.77 mL in control group respectively. The hospital stay time was comparatively shorter in the BS group than control group (3.76 ± 1.06 days in the BS group *vs*. 4.45 ± 1.86 days in the control group). Changes in hemoglobin between preoperative and the second postoperative day was not statistically significant between the two groups (15.52 ± 11.86 g/L in the BS group *vs*. 16.71 ± 15.02 g/L in the control group).

The participants were followed up until the 6th week postpartum. A total of 12 patients were lost to follow up. The progression to lochia dryness was reported to be longer in the BS group (4.24 ± 0.82 weeks in BS group *vs*. 3.86 ± 0.65 weeks in control group). Three patients reported fever (Body temperature above 38 °C) in control group after discharged. By taking oral antibiotics the symptoms relieved. None of the women had surgical complications, none were readmitted to hospital due to postpartum complications.

4. Discussion

The main finding of our study is a simple suturing method with barbed suture line could effectively reduce the blood loss in patients with placenta accrete and placenta increta in CS without increasing the risks of injuries to adjacent organs or infections. Women in the barbed suture group recovered more quickly with shorter hospital stay time than the control group. Less patients from the BS group required repeated use of uterotonic drugs. There were no significant differences in other intraoperative and postoperative parameters like operation time, ICU admission rate or puerperal morbidity.

Barbed suture line has been in clinical use since the 1960s [13,14] and was first approved by the US Food and Drug Administration (FDA) in 2004. Compared with the

Table 1. Demographical and clinical characteristics of participants.

Demographical and clinical characteristics	Barbed Suture group (N = 42)	Conventional group (N = 42)	*p*
Age (yrs), (Mean ± SD)	32.40 ± 3.58	33.14 ± 4.15	0.385
Range	26–42	26–43	
Gravidity	3.71 ± 1.95	4.07 ± 1.69	0.373
Range	1–11	1–8	
Parity	1.83 ± 0.76	2.02 ± 0.68	0.230
Range	1–4	1–5	
BMI (kg/m^2), (Mean ± SD)	26.56 ± 3.44	26.41 ± 2.54	0.818
<30, n (%)	38 (90.48%)	38 (90.48%)	
30–39.9, n (%)	3 (7.14%)	4 (9.52%)	
≥40, n (%)	1 (2.38%)	0	
Range	21.45–41.50	22.55–32.46	
Previous CS ≥2, n (%)	6 (14.29%)	5 (11.90%)	0.746
Duration of gestation (weeks), (Mean ± SD)	35.91 ± 2.29	35.71 ± 1.77	0.659
Associated medical problems, n (%)			
Anemia	9 (21.43%)	8 (19.05%)	0.786
Gestational diabetes	8 (19.05%)	7 (16.67%)	0.776
Hypothyroidism	11 (26.19%)	9 (21.43%)	0.608
Malpresentations	10 (23.81%)	12 (28.57%)	0.620
Intrahepatic cholestasis of pregnancy	1 (2.38%)	1 (2.38%)	1.00
Newborn birthweight (g), (Mean ± SD)	2590.00 ± 510.52	2503.81 ± 388.25	0.387
Range	930–3550	1300–3260	
5 min Apgar <7, n (%)	0	0	

Note: BMI, body mass index; CS, cesarean section; SD, standard deviation; yrs, years.

conventional suture method, the advantages of barbed suture method included reduced suturing time and the maintenance of the tension. Barbed suture line has two needles (PS-2, 3/8 Circle, 19 mm) in each end. The barbs faced the direction opposite to the driving needle, the anchoring effect for tissue approximation was created by the barbs thus relieved the need for additional knots like conventional suture lines. The suturing time was greatly reduced due to the elimination of the need to tie surgical knots, the barbed texture guaranteed the effective closure of the bleeding spot with maintained tension [15]. Once the bidirectional barbed suture had passed through, the tissue remained approximated without recoil and without any need for further tension to be applied. The chief surgeon could control the suture tension and perform continuous suture by himself. The assistant was relieved from tying knots during CS which requires certain technique and could help better expose the operating field. We did not detect a significant difference in the total time of the operation. One of the contributing reasons might be the barbed texture of the suture line saved the suture time. On another hand, the surgical time was determined by several factors. The surgery assistant could better expose the surgery area also make the total surgery time shorter. Rates of requirements for longer hospital stay and the need for uterotonics were also lower in BS group. This implies the potential long-term benefits of barbed suture line.

Several studies have been published on barbed suture lines in cesarean sections for uterine closure [18–21]. Barbed suture line was associated with a decrease in operating time and an improvement in blood loss. Peleg D *et al*. [20] recorded the time cost on uterine closure specifically, and found that using barbed suture line had significantly shorter time than the conventional suture, blood loss during incision closure was also decreased. Grin L *et al*. [18] also found that the suture time in uterine closure was shorter in barbed suture group, and there was no difference in the incidence of uterine hematoma. For the long-term consequences, a study with large sample size conducted by Meyer R *et al*. [19] revealed that there were no significant differences in the blood transfusion rate and maternal morbidity. They also found barbed suture was associated with reduced risk of postoperative ileus. To date, there were no studies evaluating the effectiveness of using barbed suture line in patients with PAS disorders. According to our data, the total cost in barbed suture group is equivalent to that of the control group. In spite of the increased cost in application of the barbed suture line, the need for additional hemostatic treatments was significantly lower in the barbed suture group.

PPH is still the leading cause for maternal mortality worldwide [23,24]. PPH caused by PAS disorders is a tough problem for the obstetricians and is usually intractable. However, with the advent of second and even the

Table 2. Intraoperative and postoperative parameters.

Main outcome measures	Barbed Suture group (N = 42)	Conventional group (N = 42)	*p*
Intraoperative blood loss (g), (Mean ± SD)	848.57 ± 373.20	1055.95 ± 470.88	0.028
Postoperative blood loss in the first 24 hours (g), (Mean ± SD)	42.70 ± 36.71	65.60 ± 61.44	0.041
Surgery time (minute), (Mean ± SD)	69.40 ± 10.05	67.95 ± 14.67	0.598
Repeated application of potent uterotonic drugs during surgery, n (%)	17 (40.48%)	26 (61.90%)	0.049
Application of potent uterotonic drugs after surgery, n (%)	3 (7.14%)	7 (16.67%)	0.178
Need for autologous blood transfusion, n (%)	16 (38.10%)	18 (42.86%)	0.657
Need for allogeneic blood transfusion, n (%)	6 (14.29%)	15 (35.71%)	0.023
Need for NICU admission, n (%)	9 (21.43%)	13 (30.95%)	0.321
Need for ICU admission, n (%)	10 (23.81%)	13 (30.95%)	0.189
Postoperative hospital stay time (day), (Mean ± SD)	3.76 ± 1.06	4.45 ± 1.86	0.040
Postoperative fever, n (%)	9 (21.43%)	8 (19.05%)	0.786

Note: NICU, neonatal intensive care unit; ICU, intensive care unit; SD, standard deviation.

third child boom happening in China, more women with prior CS and aged above 35 became pregnant again. This led to the increased prevalence of PAS disorders. Uterotonics including ergonovine, carbetocin and prostaglandin had their limitations in patients with respiratory and circulatory system problems. Surgical methods such Haymann's, Cho's and the classical B-Lynch suture requires certain surgical techniques. Compared with these methods, our suture method is simple. Our method was performed in mucous and myometrium layer of uterus, the procedures were observed easily and had no blind spot. The anatomies are relatively superficial without potential risks of injuring adjacent organs. It is an easy technique to learn because of these features. This procedure has its drawbacks. For patients with severe PPH, especially when it is caused by the atony of the uterine corpus, application of other compression suture methods together with efficient uterotonics are needed. This method poses a considerable risk of the narrowing of inner orifice. But we did not observe differences in amount and duration of puerperium lochia in participants of BS group. The long-term influence for menstruation still needs to be explored. For women with atony of uterine corpus or when placenta penetrated to the uterine walls and fundus, application of this method in collaboration with other compression sutures or with Bakri balloons might be an ideal option. The value of this suturing method will be further investigated.

This is the first study applying barbed suture line in Chinese patients with PAS disorders. The strengths of our study included strict exclusion criteria, rigorous calculations of sample size and the meticulous record of the surgical and post-operative parameters. We accurately timed the durations of surgery and patients' clinical and laboratory parameters after surgery. And the CS was performed by the same surgery team, which avoided performer's bias to a large extent. As a retrospective cohort study, our main limitation was the inability to blind the surgeons to the intervention. The inclusion criteria was according to intraoperative findings, and the confirmation of PAS by ultrasound or magnetic resonance imaging (MRI) was not unnecessary, so that our participants were mild in PAS without severe intraoperative and postoperative blood loss. Due to the small sample size, the longtime complications of barbed suture like postoperative ileum and maternal infectious morbidity were not found. The study was carried out in West China Second University Hospital of Sichuan University. It is a national regional medical center for women and children in southwest in China, and a national regional medical center construction project. The generalizability of our findings to other populations is not unclear. Future studies should have longer follow-up time to determine whether there is influence on the patients' menstrual status. In addition, although our patients are strongly encouraged to present to our medical center in the six postoperative weeks, some patients were still lost to follow up after discharged. Besides, when our study is published, we hope that more hospitals can promote the use of barbed suture lines to confirm our findings.

5. Conclusions

The application of barbed suture line in patients with placenta accreta/increta has favoring effects. It is a simple homostatic suture method which has its advantages to control bleeding caused by the injuries in myometrium layer after the removal of placenta during CS. Benefits of applying this technique included reduced blood loss, decreased needs for postoperative interventions and shorter hospital stay. Further research is needed to determine the long-term effects of this suture technique.

Availability of Data and Materials

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

Author Contributions

RHD, DS and YYH designed the research study. RHD and LZ performed the research. QC, QHC and YXW collected and analyzed the data. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of West China Second University Hospital of Sichuan University (Ethic approval number: 2020065). All methods were carried out in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study adheres to the AGREE guidelines. All the methods were carried out in accordance with relevant guidelines. Written informed consent was obtained from all the participants.

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Conflict of Interest

The authors declare no conflict of interest.

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