Uterus-Preserving Treatment for Placenta Percreta by Reconstruction of the Lower Uterine Segment Using Wave Compression Suture: A Retrospective Cohort Study

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Research Article

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Abstract

Purpose

To observe the hemostatic efficacy of reconstructing the lower uterine segment by wave compression sutures (WCSs) in patients with placenta previa who underwent cesarean section (CS).

Methods

Retrospective analysis the medical records with placenta previa underwent WCS at the West China Second University Hospital of Sichuan University.One-hundred-and-twenty-three women who received WCSs as the first uterine suture technique from January 1, 2016, to December 31, 2020, were included in this study. The hemostatic effect of WCS was compared according to the type of placenta previa and the intraoperative situation. All patients were followed up after CS.

Results

The hemostatic effect during CS and postpartum hemorrhage were observed. Seventy-two (58.5%) patients successfully achieved hemostasis without further intervention. Fifty-one (41.5%) cases required additional uterine artery ligation (UAL), cervical hanging maneuver (CHM), and Bakri tamponade. Seventy-nine cases exhibited thin anterior walls and lower uterine atony after placental dissection; of these, 72 (91.1%) obtained hemostasis by WCS. No patient required repeat laparotomy or hysterectomy. There were no complications attributable to the WCS following surgery. Among the five patients who had a second pregnancy, no intrauterine adhesions or abnormal uterine morphologies were caused by WCS. No ectopic or incision pregnancies occurred.

Conclusions

Reconstruction of the lower uterine segment by WCS is a suitable technique for patients with thin anterior walls and uterine atony of the lower uterine segment along with placenta previa. WCS is easy to perform, effective, and safe.

Introduction

Placental abnormalities are a major contributor to obstetric hemorrhage. Placenta accreta is one of the leading causes of maternal morbidity and mortality, and peripartum hysterectomy.[1] The incidence of placenta previa and accreta continues to increase due to increasing rates of caesarean deliveries, increased maternal age, and use of assisted reproductive technology (ART), thus demanding additional maternity-related resources.[2]

Patients with placenta previa usually experience severe hemorrhaging after placental dissection during cesarean section. The hemorrhage is due to poor contraction of the lower uterine segment and inability to compress the vessels. Prompt diagnosis and effective treatment are essential for management and are critical to prevent maternal hemorrhage.

In the past two decades, various uterine compression sutures have been developed for hemorrhage in patients with placenta previa to reduce the need for hysterectomy. Uterine sutures include the B-Lynch suture[3], modifications of the B-lynch suture[4], and the Hayman[5] suture. Although the use of such sutures has considerably decreased maternal mortality associated with postpartum hemorrhage, these methods have proved insufficient in some cases of hemorrhage from the lower uterine segment. Therefore, numerous obstetricians have devised various compression sutures to achieve hemostasis in the lower uterine segment. Methods such as the square suture technique[6], circular isthmic-cervical sutures [7], transverse annular compression sutures[8], and parallel vertical compression sutures[9]. have been employed for lower uterine segment and cervical hemorrhage. Several studies have demonstrated the advantages and efficacy of uterine compression sutures.[4, 6] However, these sutures have limitations. Further, there is no clear evidence suggesting that one technique is considerably superior to the others.

Here, we report a conservative surgical method, i.e., reconstruction of the lower uterine segment by wave compression suture (WCS), for achieving hemostasis in cesarean section, particularly for patients with thin lower uterine segment and lower uterine atony along with placenta previa. The efficacy and safety of the suture are also evaluated retrospectively.

Methods

Patient characteristics and clinical definitions

One-hundred-and-twenty-three women diagnosed with placenta previa from January 1, 2016 to December 31, 2020 underwent WCS at the West China Second University Hospital of Sichuan University. The application of this suturing technique was approved by the Ethics Committee of the West China Second University Hospital of Sichuan University (approval number: 2017004). All operations were performed by the same surgeon (XH Liu), with the assistance of other senior obstetricians. Data were collected by review of medical records. Data were anonymized and de-identified before analysis; therefore, informed consent was not required.

Patients were diagnosed with placenta previa or placenta accreta during routine prenatal ultrasound screening in the second and third trimesters. Patients suspected to have placenta increta and percreta underwent MRI to clarify the diagnosis. The diagnostic criteria for placenta previa were as follows: (i) placenta previa, where the placenta covered the cervical os and (ii) low-lying placenta, where the placental edge was within 2 cm of the cervical os.[10] Using data from cases over the last 5 years, we revised the diagnosis of all included cases according to the new diagnostic criteria. According to the depth of placental invasion, the cases were divided into three groups: placenta accreta, characterized by tight adhesion of the villi to the myometrium; placenta increta, characterized by complete invasion of the myometrium, and placenta percreta, which extended to the serosa and, occasionally, to adjacent anatomical structures.[11] Placenta accreta and placenta increta were diagnosed by the combined use of intraoperative and pathological examination. During the operation, we attempted to gently remove the placenta. If the placenta was difficult to detach, placenta accreta was confirmed. Pathological diagnosis of placenta accreta and placenta increta was confirmed by microscopic observation of placental villi invading the myometrium or reaching or penetrating the uterine serosa through the myometrium. Pathological examination was not performed in some women who received manual placenta resection or local clipping sutures due to the unavailability of resected specimens.

Patients with placenta previa underwent a scheduled cesarean section at 36–38 6/7 weeks of gestation. In the event of massive hemorrhage and other emergency situations, emergency surgery was performed as required. Transferred patients whose gestational age reached or surpassed the gestational weeks for termination of pregnancy underwent cesarean section as soon as possible. Patients who delivered before 37 gestational weeks received glucocorticoids before cesarean section to accelerate fetal lung maturation.

Adequate intravenous lines were established before surgery. Abundant blood products including packed red blood cells, fresh frozen plasma, and cryoprecipitate were prepared before surgery. The blood bank was in close proximity to the operating room, thereby making blood products readily accessible. The decision to transfuse blood products was made intraoperatively by the anesthesiologists and surgeons. Intraoperative blood transfusion was determined based on the patient's vital signs, estimated blood loss, and intraoperative hemoglobin. Blood transfusion was performed when there was < 70 g/L hemoglobin (Hb) in the postoperative period.

Cesarean section was performed under general anesthesia by the same operative and anesthesia team. Abdominal wall incision was transverse Pfannenstiel type or median incision as appropriate. After entering the peritoneal cavity, the bladder was reflected downward so as to adequately expose the underlying lower uterine segment. The uterine incision was made to avoid penetrating the placenta, and a double incision was used when necessary. Immediately after delivering the neonate, a tourniquet was placed at the lower uterine segment and bound, to effectively block the uterine blood flow temporarily. Meanwhile, oxytocin 10U intrauterine injection and 10U intravenous injection were administered immediately. Following uterine contraction, the cord was gently tugged to remove the placenta. In patients with placenta increta and placenta percreta, cesarean hysterectomy should be decided early to prevent the development of hemorrhagic shock and multiple organ failure. In these cases, attempts at placental removal are associated with a significant risk of hemorrhage.[11] In patients with focal placenta accreta or increta, the placenta was removed by manual extraction or surgical excision and the resulting defect was subsequently repaired.[11] In cases of persistent hemorrhage, ergonovine or carboprost intramuscular injections 0.2 mg or 250 μg respectively, were administered to patients with no contraindication to the drugs.

If the uterine contraction medicines failed to control hemorrhage, the second-line conservative surgical management was adopted, based on the clinical situation and the obstetrician's experience. Methods of conservative surgical management such as compression suturing, intrauterine tamponade, and uterine artery ligation (UAL) were used selectively. The same surgeon (XH Liu), assisted by other senior obstetricians, decided whether to perform WCS. Other hemostatic methods or hysterectomy were performed when necessary. The uterine incision was only closed after satisfactory hemostasis.

Surgical procedure

Reconstruction of the lower uterine segment using the WCS technique was performed in patients with thin lower uterine segment and lower uterine atony along with placenta previa or low-lying placenta. The suture strengthened the contraction of the thin lower uterine segment and compressed the endometrium to achieve hemostasis.

The vesicouterine fold was incised and the bladder moved downward to expose the lower uterine segment. The thin anterior walls of the lower uterine segment was entirely exposed and the suture area straddled the thin area of the lower uterine segment. A round needle with No. 1 absorbable thread was used for suturing. The first puncture point was selected at the thicker lateral myometrium outside the thin area or the broad ligament, if necessary. The suture was threaded through the anterior wall of the uterus from the outside to the inside. The second puncture point was located to the upper right of the first puncture point, 1–1.5 cm apart. The suture was threaded from the inside to the outside. The third puncture point was located to the lower right of the second puncture point, 1–1.5 cm apart. The suture was threaded from the outside to the inside. The stitches resembled waves. The last puncture point was in the thicker lateral myometrium at the other end. The two ends of the thread were tied outside the anterior wall of the lower uterine segment. The above procedure was repeated 2–3 times based on the length of the lower uterine segment until the lower uterine segment was reconstructed and satisfactory hemostasis was achieved. The uterine incision was only closed after satisfactory hemostasis. The procedures are illustrated in Fig. 1.

Patient information collected

Patient characteristics, including age, gestational age at delivery, gravidity and parity, previous cesarean section frequency, and previa type, were investigated.

The primary outcome parameters include the hemostatic effect, whether re-laparotomy or hysterectomy was required to control hemorrhage, other serious maternal complications, or death. Secondary outcome parameters include blood loss in the surgery and in the 24 h following surgery, the requirement for blood product transfusion, changes in Hb concentration, and any immediate complications. Intraoperative blood loss was calculated as follows: when the amniotic fluid flowed out, it was aspirated to a No. 2 aspirator, and the rest of time to a No. 1 aspirator. The blood volume in the No. 1 aspirator was recorded. After delivery of the fetus, the amniotic fluid was aspirated and the gauze pad was changed to protect the incision. Vaginal bleeding was collected with a perineal pad. The blood volume in the gauze, gauze pad, and perineal pad was estimated by weighing. The sum of the two was the intraoperative blood loss.

Vaginal bleeding was collected with a perineal pad after the operation, and the blood loss after surgery was measured by weighing.

The patients were followed up at 3 days, 6 weeks, and 1 year. Most patients returned for follow-up visits at the scheduled time, whereas some were contacted by phone or WeChat. In view of the "two child policy" of China and the pregnancy interval after cesarean section, we only investigated primiparas who underwent cesarean section from 2016 to 2018. The pregnancies of the women were tracked.

Statistical analysis

Statistical analysis was conducted using SPSS 24.0. Variables were presented as mean ± SD, frequency and percentage, and median and range where appropriate. Continuous variables were analyzed by t-test and categorical variables by chi-square test or Fisher's exact test as appropriate. A p-value of less than 0.05 ($p < 0.05$) was considered statistically significant.

Results

Between January 1, 2016 and December 31, 2020, a total of 123 patients with placenta previa/accreta underwent reconstruction of lower uterine segment by WCS as the first uterine suture technique. The clinical-epidemiological data of patients involved in the study were analyzed. The average delivery age was 33.1 ± 4.0 years (range: 26–45 years). They included 81 patients (81/123, 65.9%) who were < 35 years old, and 42 patients were ≥ 35 years old (42/123, 34.1%). Sixty-two (62/123, 50.4%) were nulliparous and 61 (61/123, 49.6%) were multiparous. Among the multiparous, 52 patients had a history of one previous cesarean section and two patients had two previous cesarean sections. Forty-five patients (45/123, 36.6%) underwent emergency cesarean section, and 78 patients (78/123, 63.4%) underwent scheduled cesarean section. The mean gestational age was $37 \pm 1^{+5}$ (29^{+3}– 40) weeks. Baseline characteristics of the patients are shown in Table 1.

Table 1
Demographic characteristics for patients with wave compression suture

Parameters	**(n = 123)**
delivery age (year) ‡	33.1 ± 4.0 (26–45)
Age (year) †	
<35	81 (65.9)
≥35	42 (34.1)
Parity †	
nulliparous	62 (50.4)
multiparous	61 (49.6)
Numbers of previous cesarean section †	
0	69 (56.1)
1	52 (42.3)
2	2 (1.6)
Timing of cesarean section †	
emergency	45 (36.6)
scheduled	78 (63.4)
mean gestational age (week) ‡	$37 \pm 1^{+5}$ (29^{+3} − 40)

†Data are given as n (%). ‡Data are presented as mean ± SD (range)

According to the type of placenta previa, 90 patients (90/123, 73.2%) had low-lying placentas and 33 patients (33/123, 26.8%) had placenta previa. Classification by placenta accreta spectrum was as follows; 72 patients (72/123, 58.5%) were normal, 43 patients (43/123,35%) had placenta accreta, and eight patients (8/123, 6.5%) had partial placenta increta. Regarding the main placental location, 68 out of 123 (55.3%) were in the anterior of the uterus, and 55 out of 123 (44.7%) were located in posterior/lateral side. The placenta previa classifications are shown in Table 2.

Table 2
Classification and statistics of placenta previa

classification	(n = 123)
Types of placenta previa	
low-lying placenta	90 (73.2)
placenta previa	33 (26.8)
Invasive depth	
normal	72 (58.5)
accreta	43 (35)
partial increta	8 (6.5)
The main placental location	
anterior	68 (55.3)
posterior / lateral sided	55 (44.7)

In the patients undergoing WCS as the first uterine suture technique, the technique was successful, requiring no further interventions, in 72 out of 123 (58.5%). In 51 out of 123 (41.5%) patients, additional UAL, CHM, or Bakri tamponade was required. None of the patients required repeat laparotomy or hysterectomy.

According to the intraoperative conditions, 79 patients were found to have thin anterior walls and uterine atony in the lower uterine segment after placental dissection. Seventy-two (72/ 79, 91.1%) of these patients regained hemostasis with WCS and seven patients (7/79, 8.9%) required WCS and UAL. There were 31 patients having thin anterior walls and uterine atony in the lower uterine segment and inner cervical hemorrhage. After WCS, the lower uterine bleeding was controlled, but there was still hemorrhage in the inner cervix. UAL and CHM were performed depending on the intraoperative situation. Ten patients experienced extensive hemorrhage on the other part of the exfoliative surface of the placenta following WCS. All regained hemostasis by further treatment with UAL. In addition, the lower uterine segment was thin and uterine atony in two twin pregnancies with placenta previa and one patient with two previous cesarean sections with placenta previa. WCS was performed to repair the lower uterine segment. However, due to intractable uterine atony, UAL and Bakri tamponade were used to achieve hemostasis.

The intraoperative conditions and hemostasis methods are summarized in Table 3.

Table 3
Intraoperative conditions and hemostasis methods

intraoperative conditions	Numbers
Thin anterior walls and uterine atony of LUS	79
WCS	72
WCS + NAL	7
Thin anterior walls of LUS with inner cervical hemorrhage	31
WCS + CHM	16
WCS + UAL + CHM	15
Thin anterior walls of LUS with extensive hemorrhage	10
WCS + UAL	10
Thin anterior walls of LUS with uterine atony	3
WCS + UAL + bakri tamponade	3

CHM, Cervical Hanging Maneuver; LUS, lower uterine segment; UAL, Uterine artery ligation; WCS, Wave compression suture

The median estimated blood loss during surgery was 597.8 ± 199.3 (400–1540) mL. The mean blood loss 24 h after CS was 63.2 ± 12.5 (41–112) mL. Only one patient experienced loss of > 100 mL (112 mL blood) in the 24 h after CS among all women. Seven patients (7/123, 5.7%) developed postpartum hemorrhage; two of these patients required a perioperative blood transfusion. Both underwent transfusion with 1.5U of packed red blood cells. The mean Hb reduction was 10.9 ± 3.5 g/L (7–28 g/L) when the preoperative Hb was compared with the lowest postoperative Hb. Bladder injury occurred in one patient because there was severe pelvic adhesion. The bladder was damaged when being pushed down.

After surgery, there were no complications attributable to the WCS such as fever and uterine erosion. No patients experienced delayed hemorrhage requiring repeat laparotomy or hysterectomy. Three days following surgery, ultrasound examinations were performed and revealed no fluid or blood accumulating in the uterine cavity in any of the 123 patients. The patients were discharged from the hospital in good conditions. All the women undergoing the WCS had normal postpartum lochia. At 42 days post-delivery, ultrasound revealed no abnormalities of the uterus or uterine cavity. There was no delay in the resumption of normal menstruation following the cessation of breastfeeding.

Of the 67 patients delivered between 2016 and 2018, 31 patients were available for the reproduction investigation. Seven patients desired to conceive. Among them, three patients had a spontaneous pregnancy 2–3 years after caesarean delivery. They all underwent caesarean deliveries uneventfully at term. During the surgery, there were no intrauterine adhesions or uterine abnormalities caused by previous

WCS. Two pregnant women underwent artificial abortion due to unwanted pregnancies. No ectopic pregnancy or incision pregnancy occurred.

Discussion

In this article we have described successful use of WCS placed in the lower uterine segment to achieve hemostasis in patients with placenta previa. To our knowledge, this is the largest case series using WCS in patients with placenta previa.

There are several challenges when performing cesarean sections in patients with placenta previa: the rapid accumulation of blood in the operation field obscures the bleeding site, and it is difficult to stop the bleeding. In an emergency situation, complex surgical procedures are not easy for inexperienced physicians. As a suitable adjunct for hemostasis, the compression sutures should fulfill three basic requirements. They should be simple, effective, and safe.

After the classic B-Lynch suture first reported in 1997,[3] a diversity of surgical sutures have been devised to treat postpartum hemorrhage, such as the square suturing technique, parallel vertical compression, and circular isthmic-cervical suture.[6, 7, 9] Thus far, no high-level evidence has demonstrated whether one suturing technique is more efficient and safer than another.[12] Cho et al.[6] reported a square suture hemostasis technique in 2000. It required four stitches to form a square; each square required to pass through the uterine wall at least eight times, and multiple squares were required. However, due to tight compression and insufficient blood supply, there is the possibility of uterine wall necrosis and uterine cavity synechiae.[12] Subsequently, Hwu et al.[9] modified this method and developed parallel vertical compression in 2005. The suture did not penetrate the entire\ posterior wall. Therefore, the hemostasis effect is uncertain and it could induce laceration of the posterior wall when the suture is tightened.[13] In 2008, Dedes and Ziogas[7] reported circular isthmic-cervical suturing to control hemorrhage from the lower segment during cesarean section in patients with placenta previa. However, there is an associated of uterine cavity occlusion because blood clots and debris entrapment are more likely to occur.[12]

Our study revealed that 91.1% of patients with thin anterior walls and uterine atony in the lower uterine segment could achieve hemostasis using WCS. No hysterectomy was required in any cases using WCS first-line. The results of our study demonstrate that this technique is effective in achieving hemostasis in patients with placenta previa with thin anterior walls and uterine atony in lower uterine segment and it has the potential to prevent hysterectomy.

Placenta previa is attached to the lower uterine segment, reaching or covering the inner cervix. The smooth muscle of lower uterine segment is relatively thin and the inner cervix is mainly composed of connective tissue with few muscle fibers. During the cesarean section in placenta previa, the lower uterine segment is unable to contract adequately and stop the flow of blood in the open vessels.[14] The anterior wall of the uterus is the weakest part of the lower uterine segment, particularly for patients with multiple cesarean sections. When the placenta is attached to the anterior wall of the uterus, the incidence of hemorrhage is higher than that when it is attached to the posterior wall.[15]

The WCS is mainly aimed at the thin anterior wall of the lower uterine segment. The principle is: first, the thin anterior walls of the lower uterine segment overlap each other to rapidly reduce the surface of the uterine wall from which the placenta detached. Second, this suture can occlude the uterine vessel beds and provide mechanical compression of the vascular sinuses of the anterior wall of the uterus to reduce blood flow to the lower uterine segment. Third, the WCS can restore the anatomical structure of the anterior wall of the uterus and contribute to postpartum uterine involution. In other words, the WCS has dual action in hemostatic compression of the bleeding surface and restoration of the anatomical structure.

In addition, our WCS has other advantages. First, the suture does not stitch the anterior and posterior walls together. It will not affect the morphology of uterine cavity. The lochia and necrotic debris can therefore be drained without the potential formation of pyometra. Second, it has no effect on the uterine blood supply, which promotes healing. Third, the thread traverses a short distance, possibly shorter than any other suture. This type of compression suture may provide greater direct tension to the compressed tissue. Fourth, WCS can be performed conveniently and quickly. Our WCS technique can be performed within a few minutes and does not require great expertise. This means the technique can be easily mastered and performed by junior surgeons in an emergency situation. Fifth, its punctures are done under direct vision, where there are no important structures such as great vessels or the ureter in the vicinity and do not injure adjacent organs.

Nevertheless, WCS has potential weakness because it is mainly aimed at the anterior wall of the lower uterine segment, it has limited ability to achieve hemostasis in other parts of the uterus, and therefore other hemostatic methods may be required. In our study, for hemorrhage from the inner cervix or uterine body, UAL, CHM or Bakri tamponade was required. Further the bladder must be pushed down to facilitate the procedure. If adhesions are present as a result of previous cesarean section, the operation is difficult and could cause injury to the bladder.

After surgery, there were no complications attributable to the WCS. All the women undergoing the WCS had normal postpartum lochia and normal menstruation following the cessation of breastfeeding. As a result of experiencing life-threatening delivery, women are often hesitant about future pregnancies, which may have made the reproductive analysis difficult. Of the five patients who had a second pregnancy, there were no intrauterine adhesions or uterine abnormalities caused by WCS. No ectopic or incision pregnancies occurred. Throughout the 5 years of observation and follow-up, we confirmed the safety of WCS.

Conclusions

Reconstruction of the lower uterine segment by WCS is suitable for patients with thin anterior walls and uterine atony of the lower uterine segment along with placenta previa. The WCS have dual functions of hemostatic compression of the bleeding surface and restoration of the anatomical structure. WCS can be performed conveniently and quickly. Nevertheless, it has limited ability to achieve hemostasis for hemorrhage from the inner cervix or uterine body. Consequently, we propose that this procedure be employed first-line, prior to more complex procedures, in patients with placenta previa who are experiencing uncontrolled hemorrhage.

Declarations

Author contributions XH-L designed the surgical technique and be responsible for the WCS. XH-L, MC, and GL-H were the principal surgeons who performed or participated in these operations. LZ and CT-S Analysis data and wrote this article. All authors approved the final version of the article.

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Data availability All data are available as SPPS file.

Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest to declare.

Ethical approval The application of this suturing technique was approved by the Ethics Committee of the West China Second University Hospital of Sichuan University (approval number: 2017004).

Informed consent Data were collected by review of medical records. Data were anonymized and de-identified before analysis; therefore, informed consent was not required.

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Figures

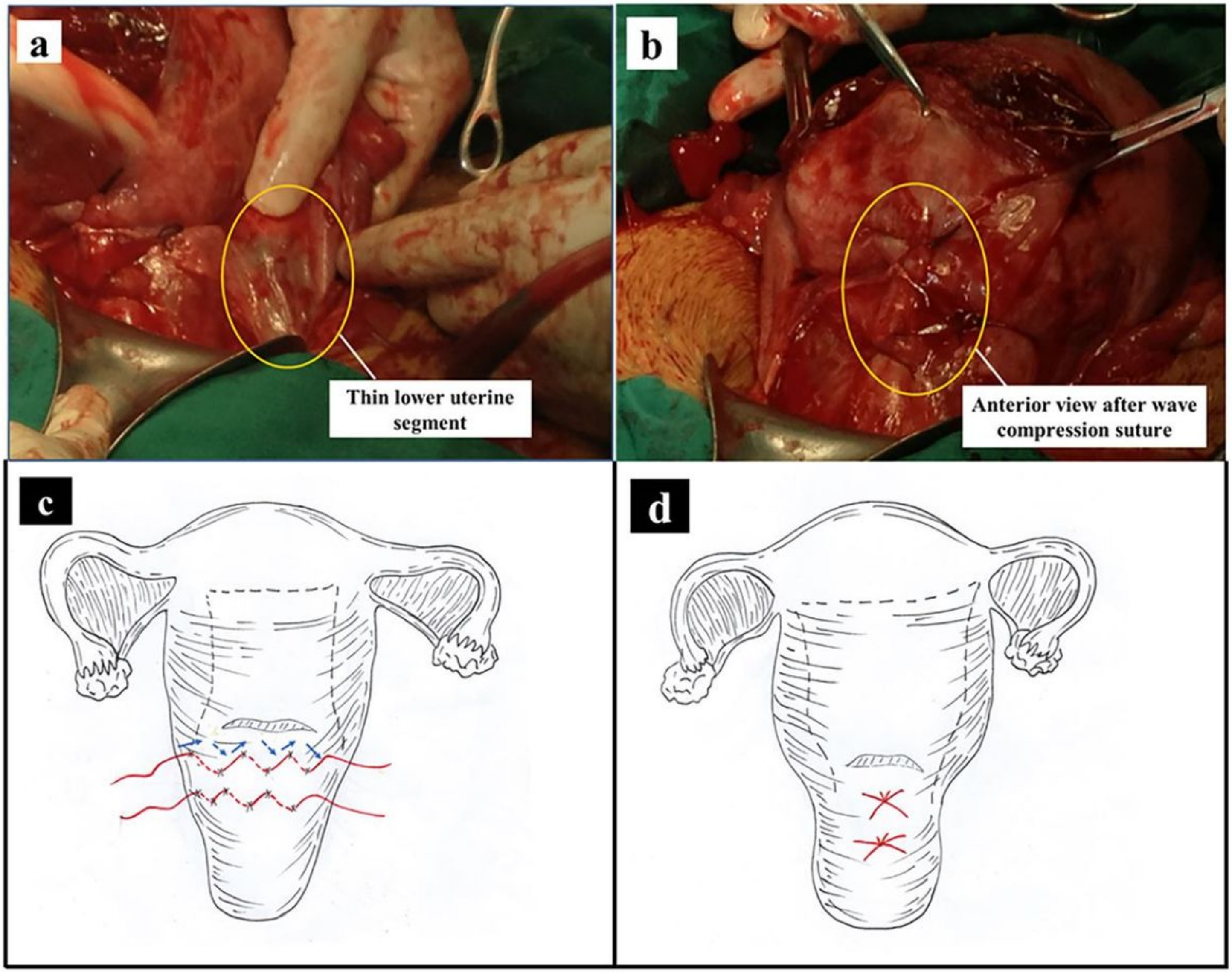

Figure 1

intraoperative photographs and schematic diagram of surgical procedure (a) Thin anterior walls of the lower uterine segment after placental dissection (c)The surgical procedure. The stitches look like wave. (b,d)Anterior view of uterus after wave compression suture.