Multifaceted spiral suture: A hemostatic technique in managing placenta praevia or accrete

A retrospective study

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Abstract

Patients with total placenta previa and past history of cesarean delivery often experience overwhelming hemorrhage during childbirth. In order to control intraoperative and postoperative bleeding, we propose a novel multifaceted spiral suture of the lower uterine segment which directly sures the bleeding site.

To evaluate the efficacy and safety of multifaceted spiral suture, a retrospective study was conducted using data from 33 patients with total placenta praevia and caesarean history.

All participants underwent multifaceted spiral suture and no patient experienced uncontrollable bleeding or underwent hysterectomy.

The average blood loss of all patients involved was 1327.3 ± 1244.1 mL. Five patients reported blood loss exceeding 3000 mL (15.15%), and the highest reached to 4000 mL. No complications such as fever, pyometra, synechiae, or uterine necrosis were observed. Three cases (9.09%) reported hematuria in the first 3 days following surgery and spontaneous resolution were observed within 3 to 7 days following insertion of indwelling catheters. No complaints were received during 6-month follow-up visits.

These findings suggest that multifaceted spiral suture is a practical, feasible, and promising technique in potentially minimizing postpartum bleeding and avoiding hysterectomy for patients with placenta praevia or accrete.

Abbreviations: LUS = lower uterine segment, MRI = magnetic resonance imaging, MSS = multifaceted spiral suture.

Keywords: multifaceted spiral suture, placenta accrete, placenta praevia, postpartum hemorrhage

1. Introduction

Severe postpartum hemorrhage (PPH) usually occurs in women with placenta praevia, especially with past history of cesarean delivery and a complication of placenta accreta. It has been reported that the prevalence of placenta praevia was 0.52% to 1.24%. Patients with total placenta previa and past history of cesarean delivery often experience overwhelming hemorrhage during childbirth. This combination of conditions has been termed as pernicious placenta previa. High prevailing cesarean section rates and the implementation of the 2-child policy from 2016 account for a gradual increasing incidence of pernicious placenta previa in China.[1,2] The fatality associated with maternal hemorrhage and shock after detachment of placental tissues are challenging to any obstetrician.[3] Although many surgical techniques such as B-Lynch compression suture, parallel vertical suture, and interventional methods (e.g., balloon placement, arterial embolization) have been devised,[4–10] the reported hysterectomy rate for women with placenta praevia and past history of cesarean delivery was still high.[11–13] Jauniaux and Bhide[14] systematic reviewed 10 studies on the management of placenta previa accreta at delivery and found 89.7% (208/232) cases had an elective or emergent cesarean hysterectomy. The widely-used external compression suture techniques aim at controlling massive bleeding by constricting outlying tissues. However, hemothrosis may not be achieved due to anatomical changes associated with pregnancy, particularly in the lower
uterine segment (LUS). Due to the shortcomings of the conventional method, we propose an innovative concept where hemostasis is achieved by directly suturing the bleeding site instead of indirect compression sutures. Enthused by this theory, we further developed the multifaceted spiral suture (MSS) of the LUS to control intraoperative and postoperative bleeding.\textsuperscript{[13]} To further evaluate the efficacy and safety of MSS, we conducted a retrospective study using data from 33 patients with total placenta praevia and caesarean history.

2. Materials and methods

A retrospective study was conducted using data from 33 patients with pernicious placenta previa at Tongji Hospital between May 1, 2014 and October 31, 2016. All data were collected and analyzed from January 1, 2017 to June 1, 2017. This study required the following criteria:

History of cesarean section at least 2 imaging evidence of total placenta previa where placental tissue completely covered the internal cervical os after 20 weeks of gestation.\textsuperscript{[16–18]} If transabdominal sonography was inconclusive, magnetic resonance imaging (MRI) was ordered during 28 to 36 gestational weeks.\textsuperscript{[19]} Cesarean delivery using MSS is performed. No other surgical techniques including external B-Lynch compression sutures or interventional methods were used. All patients were followed up for 6 months with telephone. Information pertaining to general data, surgical procedures, intraoperative and postoperative records were obtained from medical archives after the approval of the Ethics Committee of Huazhong University of Science and Technology. Placental conditions were diagnosed by transabdominal sonography or MRI according to related references.\textsuperscript{[16–18]}

For all patients with suspected accrete or adherent placenta, their removed placenta tissue would be delivered to the Pathology Department of Tongji Hospital. If pathologists confirmed that villi were attached to the myometrium, the patient will be diagnosed with placenta accreta. LUS vascular engorgement and adhesions of bladder and uterus were evaluated by at least 2 licensed obstetricians during operations and the amount of blood lost was estimated by the number of wet surgical towels. The demographic and perioperative data were analyzed using SPSS version 19.0 (IBM, Armonk, NY) and the results were reported as the average value and standard deviation.

The following points outline our standard MSS of the LUS procedure (see Supplementary Video 1, http://links.lww.com/MD/C11 which demonstrates the standard procedure of MSS of the LUS and Video 2, http://links.lww.com/MD/C10 which shows the practical procedures of the MSS of the LUS in a patient).

1. Cesarean preparation and procedure: The patient is placed in supine position. A collecting bag is placed under the hips to gather any vaginal blood discharge. Prior to surgery, the blood bank will be forewarned to prepare for sufficient blood and blood products. An intraoperative blood salvage device is also on standby in case of copious rapid blood loss. An abdominal longitudinal midline incision is preferred regardless of previous surgical scars. Once the abdomen has been cut open and uterus exposed, the surgeon palpates the LUS to find the most accessible point with respect to fetal presentation and placental position. The newly born infant is delivered and resuscitated according to neonatal resuscitation program (NRP).

2. Placental delivery and MSS of the LUS: Following fetal and placental deliveries, spiral suture procedure is routinely employed. Although the principles are similar, the technique might require modifications according to cases. The following 5 points summarize MSS of the LUS procedure:

a. Exposure: If there are no serious pelvic adhesions, the uterus is pulled out of the abdominal cavity and then preserved by wrapping a warm, moistened gauze. This enables a complete visualization and identification of adhesion sites on the LUS, anterior muscular layers, or bladder.

b. Bilateral clamping of uterine arteries: As demonstrated by Fig. 1A, SHA’s clamps are fixed on each side of the uterus to control blood flow via the uterine arteries until the bleeding situation has been addressed and uterus sutured.

c. Excision of placental remnants: Any retained placental fragment, especially those attached to the LUS near the internal cervical os, must be completely and swiftly removed by blunt and sharp dissection.

d. MSS of the LUS: the LUS can be divided into 4 areas, namely: anterior, posterior, left, and right. Each of them has their respective serosal and mucosal layers. As demonstrated by Fig. 1B and C, a continuous running suture is made inferosuperiorly, starting from the internal cervical os (from the cervical area towards the uterine cavity) until the bleeding site has been surpassed by 1 cm. Since the LUS is a 4-dimensional entity, the position of the placenta, or adhesion location and even bleeding outcome differ greatly in every cases. Preoperative assessment involving imaging is essential in identifying troublesome areas such as abundant vascular supplies or regions with clots associated with placental invasion. Once a particular area has been sutured, the bleeding situation is re-evaluated. After assessment, we have noticed that 1 to 3 areas typically require suturing, and

Figure 1. Schematic representation of standard multifaceted spiral suture of the lower uterine segment procedure. A. Bilateral clamping of uterine arteries: special atraumatic vascular clamps (SHA’s clamps) are fixed on each side of the uterus to control blood flow via the uterine arteries until the bleeding situation has been addressed and uterus sutured. B. A continuous running suture is made inferosuperiorly, starting from the internal cervical os (from the cervical area towards the uterine cavity) until the bleeding site has been surpassed by 1 cm. C. The lower uterine segment can be divided into 4 areas, namely: anterior, posterior, left, and right. Once a particular area has been sutured, the bleeding situation is evaluated. After assessment, we have noticed that 1 to 3 areas typically require suturing, and if need be, all 4 areas.
In this study, the average age of all patients was 31.4±3.8 (mean±SD) years (range, 21–37 years). The average gestational age was 36.7±1.9 weeks. All patients had previous cesarean history, of which 3 cases are multiparous. The demographic characteristics of the 33 patients in this study are shown in Table 1. Among all 33 patients, no patient experienced uncontrollable bleeding or underwent hysterectomy. The average blood loss was 1327.3±1244.1mL. Five patients reported blood loss exceeding 3000mL (15.15%), and the highest reached to 4000mL. No complications such as fever, pyometra, synechiae, or uterine necrosis were observed. Three cases (3/33, 9.09%) complained of hematuria in the first 3 days postoperation, which is a common short-term complication. There was spontaneous resolution after 3 to 7 days of indwelling catheter. No other complication such as fever, pyometra, synechiae, and uterine necrosis were found within 6 months after the operation while all patients reported resumptive menstruations. All of the patients were discharged from the hospital in good condition, and no readmissions or reoperations were required. During 6-month follow-up visits, all patients reported resumptive menstruations while no subsequent pregnancies has been reported so far, so its impact on secondary pregnancy need further clinical practice and longer follow-up. The intraoperative data of patients are listed and summarized in Table 2.

In the course of our research, some particular characteristic changes of the LUS emerged. They may occur individually or simultaneously according to variable conditions. Some characteristic changes are discussed below and a full account can be viewed in Fig. 2. These photos are collected from 4 typical participants with pernicious placenta previa after receiving their informed consent.

a. Vascular engorgement (Fig. 2A): The uterine artery from internal iliac artery is the major blood supplier but blood

### Table 1
Demographic characteristics of 33 pernicious placenta previa patients in this study.

| Variables                          | No. of patients | %   |
|-----------------------------------|-----------------|-----|
| Age                               |                 |     |
| <30                               | 10              | 30.3|
| 30–35                             | 19              | 57.6|
| >35                               | 4               | 12.1|
| Gestational age                   |                 |     |
| <37 wk                            | 18              | 54.5|
| 37–39 wk                          | 12              | 36.4|
| >39 wk                            | 3               | 9.1 |
| Number of pregnancies             |                 |     |
| 2                                 | 6               | 18.2|
| 3                                 | 14              | 42.4|
| >3                                | 13              | 39.4|
| Number of births                  |                 |     |
| 1                                 | 29              | 87.9|
| >1                                | 4               | 12.1|
| Number of previous cesarean sections |              |     |
| 1                                 | 30              | 90.9|
| >1                                | 3               | 9.1 |

if need be, all 4 areas. A 0/0 vicryl suture is preferably used to provide control over suturing depth, such that sutures do not perforate uterine serosal layer and damage the anterior uterine wall, and create adhesion with the bladder via the mucosal surface of the bladder.

e. Inspection and reinforcement: The atraumatic clamps are released and the uterus is examined interiorly and exteriorly for any abnormal bleeding. In such cases, reinforcement sutured is applied in suspicious areas.

3. Intraoperative hemostasis: After fetal delivery, 40U oxytocin is routinely administered; 20U via 500mL IV drip and the other 20U by intramuscular injection into the uterine body. Supplementary intraoperative hemostasis involves ligation of ascending and/or descending branches of the uterine arteries and intrauterine balloon tamponade. Once the uterus has been sutured shut and before closure of the abdominal cavity, the patient’s vagina is checked for any signs of active bleeding. If intractable bleeding is observed and/or there is a constant decline in blood pressure, a hysterectomy is performed.

4. Postoperative management: Postoperative monitoring measures include maternal ECG monitoring, placing a mat underneath the patient, and determining vaginal bleeding condition. Should bleeding exceed 1000mL within 6 hours after surgery, bilateral iliac artery embolization be advised. If bleeding is still uncontrollable, a total hysterectomy should be performed.

### Table 2
Intraoperative characteristics of 33 pernicious placenta previa patients in this study.

| Variables                                         | No. of patients | %   |
|---------------------------------------------------|-----------------|-----|
| Placental conditions except for placenta previa    |                 |     |
| Placenta accreta                                   | 15              | 45.5|
| Highly suspected of placenta accreta               | 9               | 27.3|
| No abnormality                                     | 9               | 27.3|
| Lower uterine segment vascular engorgement         |                 |     |
| Severe engorgement                                 | 13              | 38.4|
| Mild engorgement                                   | 4               | 12.1|
| No engorgement                                     | 16              | 48.5|
| Adhesions of bladder and uterus                    |                 |     |
| Severe adhesion                                    | 5               | 15.2|
| Mild adhesion                                      | 9               | 27.3|
| No adhesion                                       | 19              | 57.6|
| The amount of blood lost                           |                 |     |
| <1000mL                                           | 19              | 57.6|
| 1000–3000mL                                        | 9               | 27.3|
| >3000mL                                           | 5               | 15.2|
| The amount of blood transfused                     |                 |     |
| <1000mL                                           | 21              | 63.6|
| 1000–3000mL                                        | 9               | 27.3|
| >3000mL                                           | 2               | 6.1 |
| Decrease in hemoglobin                             |                 |     |
| <0                                                | 9               | 27.3|
| 0–20 g/L                                          | 15              | 45.5|
| >20 g/L                                           | 6               | 18.2|
| Unknown                                           | 3               | 9.1 |
vessels originating from the bladder and vagina contribute to providing blood to the uterus and are affected by tremendous blood loss. Experienced obstetricians evaluated patients’ vascular engorgement of the LUS during the surgery and found that 12.1% (4/33) patients had mild vascular engorgement and 38.4% (13/33) patients had severe vascular engorgement.

b. Abnormal dilation of the LUS (Fig. 2B). The transverse diameter of the LUS may enlarge and become similar to that of the uterine body. In such circumstances, the contact surface of placenta is extremely wide and many small arteries connect to the uterine wall irrespective of placental implantation or adhesion.

c. Extremely thin anterior wall (Fig. 2C and D). The front wall is weakened or even translucent after the delivery of the placenta. The muscle of the LUS is relatively weak, especially in the anterior section. Imaging evidence support that myometrial fibers are not continuous or even missing.

d. Adhesions of bladder and uterus. Adhesions of bladder and uterus are common in pernicious placenta previa patients owing to previous cesarean section history. In our study, experienced obstetricians evaluated adhesions of bladder and uterus in the surgery. The statistics showed 27.3% (9/33) patients had mild adhesions and 15.2% (5/33) patients had severe adhesions.

4. Discussion

Improved technology, pharmacotherapy and interventional therapy, has shown great effects for PPH. But surgical suture remains the most economical and effective hemostatic method. Since the B-Lynch surgical technique for the control of massive PPH has been first reported in 1997,[4,5] many homogeneous external compression sutures including the square suturing technique,[6] parallel vertical compression suture,[7] and funnel compression suture[8] have been devised. They mostly control PPH by compressing hemorrhagic sites of the endometrium or myometrium. For example, the B-Lynch suture generates traction on the surface and constricts myometrial fibers which compresses the uterine artery and veins, reducing blood flow.[4,5] On the other hand, the square suturing technique (Cho suture) controls hemorrhage by penetrating uterine walls anteroposteriorly to form a circle around the bleeding portion.[6] These aforementioned sutures have shown unsatisfying hemostatic effects since their rationale aims at reinforcing myometrial fibers’ contraction. Such effects are inconclusive in pernicious placenta previa cases involving the lower uterine segment since the latter is deficient in myometrial fibers and associated hysterectomy rates remain 8% to 11%.[19,20] Moreover, these sutures risk occluding the uterine cavity and result in infection, pyometra, synechiae, obstruction, uterine necrosis, and even infertility because of the restrictive compression and drainage of the uterine cavity.[18] Furthermore, pernicious placenta previa patients’ placenta often attach to the original scar of the lower uterine segment where musculature are fractured and the myometrial fibers has poor contractility and respond poorly to tocolytics especially in cases where the weakened frontal wall cannot effectively control severe bleeding through muscular contraction and compression. To make matters worse, placenta overlying the prior cesarean incision also carries a potential risk for accrete. Therefore, pernicious
placenta previa patients’ characteristic anatomical changes will weaken the hemostatic effects of conventional sutures. In view of the above-mentioned anatomical changes and unsatisfying hemostasis effects of traditional external compression techniques, we put forward an innovative concept. It involves direct suturing of the bleeding site to provide better hemostasis than indirect compression sutures. Guided by this novel theory, we propose multifaceted spiral suture in the LUS where directly suturing the bleeding area could control intraoperative and postoperative bleeding.

The benefit of MSS is that hysterectomy rate decreases significantly compared with other sutures. Jauhaisna and Bhide\(^ {14} \) systematic reviewed 10 studies on the management of placenta previa accreta at delivery and found 89.7% (208/232) cases had an elective or emergent cesarean hysterectomy.\(^ {14} \) In our study, no patient experienced uncontrollable bleeding or hysterectomy, while for those of control patients from the same center implemented with other traditional or classical hemostatic techniques, the ratio of hysterectomy reached to 7.04% (5/71). Several more specific studies based on this database are presently under way. We will further enlarge the sample size and investigate more characteristics of MSS. What’s more, since MSS are applied on the wound of the LUS after removal of placental fragments, it does not affect cervical morphology and can help restoring normal anatomical morphology of the uterus. In addition, the sutures are applied to bleeding areas directly and operate on the inside of the uterine cavity rather than on the outside. So the sutures do not intrude on implementation of other supplementary hemostatic methods such as placement of balloons or uterine artery ligation. In common practice, surgeons might need to separate adhesions between bladder and uterus to execute compression sutures. But in these patients, many small placental arteries vegetate across the uterine wall and the bladder. Hence, placental separation can also engender extensive bleeding at adhesion sites. Furthermore, our standard MSS procedure simplifies the separation of the bladder and uterus to avoid undesired bleeding which also reduces the total suture time. However, the suture may penetrate the vesicular mucosal surface and lead to bladder injury in patients with extremely thin anterior uterine walls or those presenting with severe adhesions between uterus and bladder. Therefore, the sutures require skillful execution and adequate experience. The shortcomings of the suture technique described here are limited by the number of patients and the lack of long-term comparisons with other suture methods, especially potential safety impact of the drainage of the uterus as it may increase the LUS wall tension and decrease the size of os. We are currently collecting further data for more profound comparisons between this procedure and other compression sutures.

5. Summary

The article introduces an innovative suture theory and the creation of a brand new suture method—MSS of the LUS—to control intraoperative and postoperative bleeding following the pathological changes in placenta previa or accrete patients. The rationale for using MSS arises from the lack in musculature in the lower uterine cavity that inhibits its ability to contract and assert hemostatic action on placental insertion site. This technique can also assist the uterus in restoring its normal anatomical morphology and is not detrimental to the application of other additional hemostatic tools. MSS is a good surgical technique for uncontrollable hemorrhage in placenta previa or accrete patients. It dramatically decreases the hysterectomy rate and appears to minimize both immediate and long-term complications. However, further studies are necessary to demonstrate the long-term safety and improve this technique’s operative procedure in order to control rapid blood loss after delivery of placentas and to protect the bladder and adjacent organs. Furthermore, its impact for secondary pregnancy also requires supplementary clinical expertise and longer follow-up.

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