Conservative Surgical Management Role in Reducing Postpartum Haemorrhage

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Abstract
Background: Obstetric hemorrhage is the most common and dangerous complication of childbirth. This was redefined in 2017 by the American College of Obstetrics and Gynecology as a cumulative blood loss greater than 1000 mL with signs and symptoms of hypovolemia within 24 hours of the birth process, regardless of the route of delivery. Postpartum hemorrhage is the leading cause of morbidity and mortality in childbirth. PPH occurs in approximately 1% to 6% of all deliveries. Uterine atony, the primary cause of PPH, accounts for 70% to 80% of all hemorrhage. Conservative surgical management in PPH includes surgical procedures that can avoid hysterectomy and its morbidity, as well as can preserve patient's fertility. The most used procedures are the hemostatic sutures, which refer to the ligation of pelvic vessels (LPV) and uterine compressive sutures (UCS). The success rate will depend on the cause, intensity and location of the bleeding as well as on the type of procedure chosen and the surgeon's ability to perform the procedure. Theoretically, UCS should be able to control bleeding more quickly and in a safer manner when compared to hysterectomy. However, when it fails to stop PPH, radical surgery is indicated, since the patient's prognosis may worsen (as the time elapsed from diagnosis until the control of the bleeding will be prolonged) and the mortality rates may increase. For these reasons the conservative surgical management should be included into a PPH protocol (like intravenous tranexamic acid and uterine massage), so the provider is able to decide, properly, how and when to use them.
Keywords: Conservative Surgical Management, Postpartum Haemorrhage.

Introduction

Obstetric hemorrhage is the most common and dangerous complication of childbirth. This was redefined in 2017 by the American College of Obstetrics and Gynecology as a cumulative blood loss greater than 1000 mL with signs and symptoms of hypovolemia within 24 hours of the birth process, regardless of the route of delivery **(1)**

While this change was made with the knowledge that blood loss at the time of delivery is routinely underestimated, blood loss at the time of vaginal delivery greater than 500 mL should be considered abnormal with the potential need for intervention **(2)**.

Postpartum hemorrhage is the leading cause of morbidity and mortality in childbirth. PPH occurs in approximately 1% to 6% of all deliveries. Uterine atony, the primary cause of PPH, accounts for 70% to 80% of all hemorrhage **(3)**.

Primary postpartum hemorrhage is bleeding that occurs in the first 24 hours after delivery, while secondary postpartum hemorrhage is characterized as bleeding that occurs 24 hours to 12 weeks postpartum **(1)**

Etiology:

Acute postpartum hemorrhage has several potential causes and can be mainly divided into primary and secondary **(4)**.

A- Primary causes of postpartum hemorrhage include:

- Uterine atony
- Genital tract lacerations
- Retained placenta
- Uterine inversion
- Abnormal placentation
- Coagulation disorders

Uterine atony, or lack of effective contraction of the uterus, is the most common cause of postpartum hemorrhage. Postpartum hemorrhage in a previous pregnancy is a significant risk factor and providers should make all the effort to establish its severity and cause **(4)**.

B- Secondary causes of postpartum hemorrhage include:

- Retained products of conception
- Infection
- Subinvolution of the placental site
- Inherited coagulation deficits **(4)**.

Pathophysiology:

Risk factors for postpartum hemorrhage (PPH) are dependent on the etiology of the hemorrhage. Risk factors for uterine atony include high maternal parity, chorioamnionitis, prolonged use of oxytocin, general anesthesia, and conditions that cause increased distention of the uterus such as multiple gestation, polyhydramnios, fetal macrosomia, and uterine fibroids. Risk factors that can lead to uterine inversion include excessive umbilical cord traction, short umbilical cord, and fundal implantation of the placenta **(5)**.
Genital tract trauma risk factors include operative vaginal delivery and precipitous delivery. Retained placental parts and abnormal placentation are more common in patients with previous uterine surgery.The California PPH toolkit states that those patients who are bleeding on presentation to delivery, those with a history of PPH, hematocrit less than 30%, history of bleeding diathesis or coagulation deficit, morbidly adherent placenta, or with hypotension or tachycardia on presentation to delivery should be considered high risk for PPH on admission **(6)**.

Evaluation:

Initial evaluation of the patient should include a rapid assessment of the patient's status and risk factors. In postpartum women, signs of blood loss such as tachycardia and hypotension may be masked, so if these signs are present, there should be a concern for considerable blood volume loss (greater than 25% of total blood volume). Continuous assessment of vital signs and ongoing estimation of total blood loss is an important factor in ensuring safe care of the patient with PPH. An exam of the patient at the time of hemorrhage can help to identify the probable cause of bleeding focused on any specific risk factors the patient may have. A rapid assessment of the entire genital tract for lacerations, hematomas, or signs of uterine rupture should be performed. A possible manual exam and extraction for any retained placental tissue or assessment by bedside ultrasound may be a part of the evaluation. A soft, "boggy" or non-contracted uterus is the common finding with uterine atony. Uterine inversion presents as a round bulge or mass with palpation of the fundal wall in the cervix or lower uterine segment and is often associated with excessive traction on the umbilical cord or abnormally adherent placenta. Widespread bleeding, such as from venipuncture sites, is a sign of disseminated intravascular coagulation (DIC) **(7)**.
Laboratory studies can be ordered in a PPH to help evaluate and manage the patient, although interventions such as medication or blood product administration should not be withheld, pending the results of such studies. Type and screen or crossmatch may be ordered to prepare for possible blood transfusion. Complete

blood count to assess hemoglobin, hematocrit, and platelets can be evaluated at intervals, although lab values often lag behind the clinical presentation. Coagulation studies and fibrinogen will be useful in the patient where DIC is suspected. The treatment and management of postpartum hemorrhage are focused on resuscitation of the patient while identifying and treating the specific cause. Maintaining the hemodynamic stability of the patient is important to ensure continued perfusion to vital organs. Ample intravenous (IV) access should be obtained. Careful direct assessment of cumulative blood loss is important, and a focus should be on the early initiation of protocols for the release of blood products and massive transfusion protocols **(7)**.

Conservative surgical management in PPH includes surgical procedures that can avoid hysterectomy and its morbidity, as well as can preserve patient's fertility. The most used procedures are the hemostatic sutures, which refer to the ligation of pelvic vessels (LPV) and uterine compressive sutures (UCS). The success rate will depend on the cause, intensity and location of the bleeding as well as on the type of procedure chosen and the surgeon's ability to perform the procedure**(8).**

Theoretically, UCS should be able to control bleeding more quickly and in a safer manner when compared to hysterectomy. However, when it fails to stop PPH, radical surgery is indicated, since the patient's prognosis may worsen (as the time elapsed from diagnosis until the control of the bleeding will be prolonged) and the mortality rates may increase. For these reasons the conservative surgical management should be included into a PPH protocol (like intravenous tranexamic acid and uterine massage), so the provider is able to decide, properly, how and when to use them **(9)**.

Table (1) Efficacy of conservative surgical techniques to stop uterine bleeding by topographic area and cause of PPH **(10)**.

	Topographic area and cause of bleeding		
	Bleeding from the uterine body (S1)		**Bleeding from the uterine cervix and upper vagina (S2)**
Procedure	**(Uterine atony)**	**(Placenta acreta)**	**Any cause**
Bilateral uterine artery ligature	Excellent	Good	Poor or ineffective
B-Lynch	Excellent	Good	Poor or ineffective
Cho	Good	Excellent	Excellent
Hayman	Excellent	Good	Poor or ineffective
Pereira	Excellent	Good	Poor or ineffective
Selective lower vascular ligature	Not applicable	Not applicable	Excellent

I. UTERINE COMPRESSIVE SUTURES

Uterine compressive sutures (UCS) are an excellent surgical strategy to stop PPH. They can offer an easy, quick, safe, and effective control of bleeding at a laparotomy, especially in locations with low technical resources. It can avoid hysterectomy and its morbidity can also preserve patient fertility in most cases. The most known and used type UCS is the one described by B-Lynch *et al.* (1997) and its variations.[7] Other techniques, such as Cho *et al.* (2000), Hayman *et al.* (2002) and Pereira *et al.* (2005) sutures have also been well studied. The main mechanisms of action of UCS are to promote a mechanical compression on specific uterine areas as well as a reduction of blood flow in the uterine arteries **(8)**.

Indications

The primary indication for UCS is a hemorrhage resulting from uterine atony that: (a) does not respond to uterotonics after a cesarean section, or (b) does not respond to pharmacological treatment and other nonsurgical management (such as intrauterine tamponade balloon and non-pneumatic anti-shock garment) in vaginal delivery. However, UCS can be used in any situation that compression of the uterus is considered an important step to control uterine bleeding. This situation may occur in cases of placenta previa or acreta, or even bleedings related to some types of uterine lacerations. UCS have been indicated as a prophylaxis for acute recurrence of uterine inversion **(11)**.

Most authors describe the importance of performing an efficacy test before the procedure (through manual uterine compression and observation of the blood loss), in order to see if uterine compression is sufficient to control bleeding. If this maneuver does not control hemorrhage, UCS is not indicated, as it will probably fail to control PPH and increase the duration of the bleeding. In these situations, the health professional team should move to the next step of PPH management **(10)**.

Efficacy

When it is indicated, UCS's efficacy for controlling the bleeding and avoiding hysterectomy ranges from 60% to almost 100% , but the overall success rate is usually superior to 80% in most series. Until now, there is no consistent evidence to indicate "the best and unique" UCS technique. The studies usually do not find significant differences in the success rate among different sutures. Palacios-Jaraquemada in 2011 , however, showed interesting data, in which UCS efficacy varies according to the area and the cause of uterine bleeding. In this study, the sutures of B-Lynch, Hayman, Cho and Pereira's achieved a >94% success rate for controlling bleeding due to uterine atony; but, for bleeding from the cervix or upper vagina only Cho suture was effective (>92% success rate), and the others were considered to have low efficacy or even to be ineffective for treating PPH in these areas**.** Some other conditions interfere with UCS's efficacy. It Was showed that delays of 2–6 hours, between delivery and uterine compression suture, were associated with a fourfold increase in the risk of failure. Also, the author pointed out that women were more likely to have radical surgery if they were aged 35 years or older, multiparous or had a vaginal delivery **(10)**.

UTERINE COMPRESSIVE SUTURES TECHNIQUES

UCS can be classified in different ways. All classifications were created to help improve understanding about the suture's mechanism of action, application, selection, complication and validity of these procedures. Here, is presented one classification that considers six categories for UCS (Table 2) **(10)**.

Table (2)Classification of uterine compressive surgery, based on six criteria (10).

Categories/criteria	Subcategories			
According to the mode of UCS	a) Approximating both walls of uterus together, e.g. B-Lynch and Hayman sutures	b) Stapling both walls together, e.g. Cho, Hwu and ‘‘U’’ sutures	c) Sandwich sutures, e.g. Nelson suture	d) Location area sutures in single wall (either anterior or posterior walls), e.g. figure-of-eight suture
According to the direction of suturing	a) Longitudinal sutures, e.g. B-Lynch and Hayman sutures	b) Transversal sutures, e.g. Ying suture	c) Crisscrossing sutures, e.g. M-Y sutures	d) Sutures around the uterus, e.g. Pereira suture
According to the anatomic region	a) Lower uterine segment, e.g. Hwu, Dedes sutures, etc.	b) Upper uterine segment, e.g. B-Lynch suture and Hayman suture	c) Location area sutures, viz., focus region suture, e.g. Cho suture	d) Sutures around the uterus, e.g. Pereira suture sutures applied longitudinally and transversally around the uterus
According to the causation of PPH	a) Uterine atony, e.g. B-Lynch suture and Hayman suture	b) Placental abnormalities, e.g. Cho suture and Li suture	c) Laceration of the endometrium, e.g. Cho suture or figure-of-eight suture, and so on	
According to whether the sutures transfix uterine cavity	a) Transfixing uterine cavity, e.g. Hayman suture	b) No transfixing uterine cavity, e.g. Zheng suture		
According to whether the sutures are removable	a) Irremovable suture, e.g. figure-of-eight suture, Cho suture, and so on	b) Removable uterine compression sutures, e.g. Aboulfalah suture		

B-Lynch compressive suture

The B-Lynch compressive suture is the most known and probably the most widely used compression suture, it is an easy and very efficient procedure to control hemorrhages in the uterine body . This suture has success rates above 90% due to atony, and controls bleeding by compressing the uterine body’s anterior wall against its posterior wall . The original technique requires hysterotomy, but some variations of B-Lynch technique may not need it. A test for the potential efficacy of the B-Lynch suture before performing the procedure is essential. The uterus is exteriorized and bimanual compression is performed. An assistant stands between the patient’s legs and evaluates the presence and extent of the bleeding. If the bleeding stops on applying such compression, there is a good chance that application of the B-Lynch suture will work and stop the bleeding **(10)**.

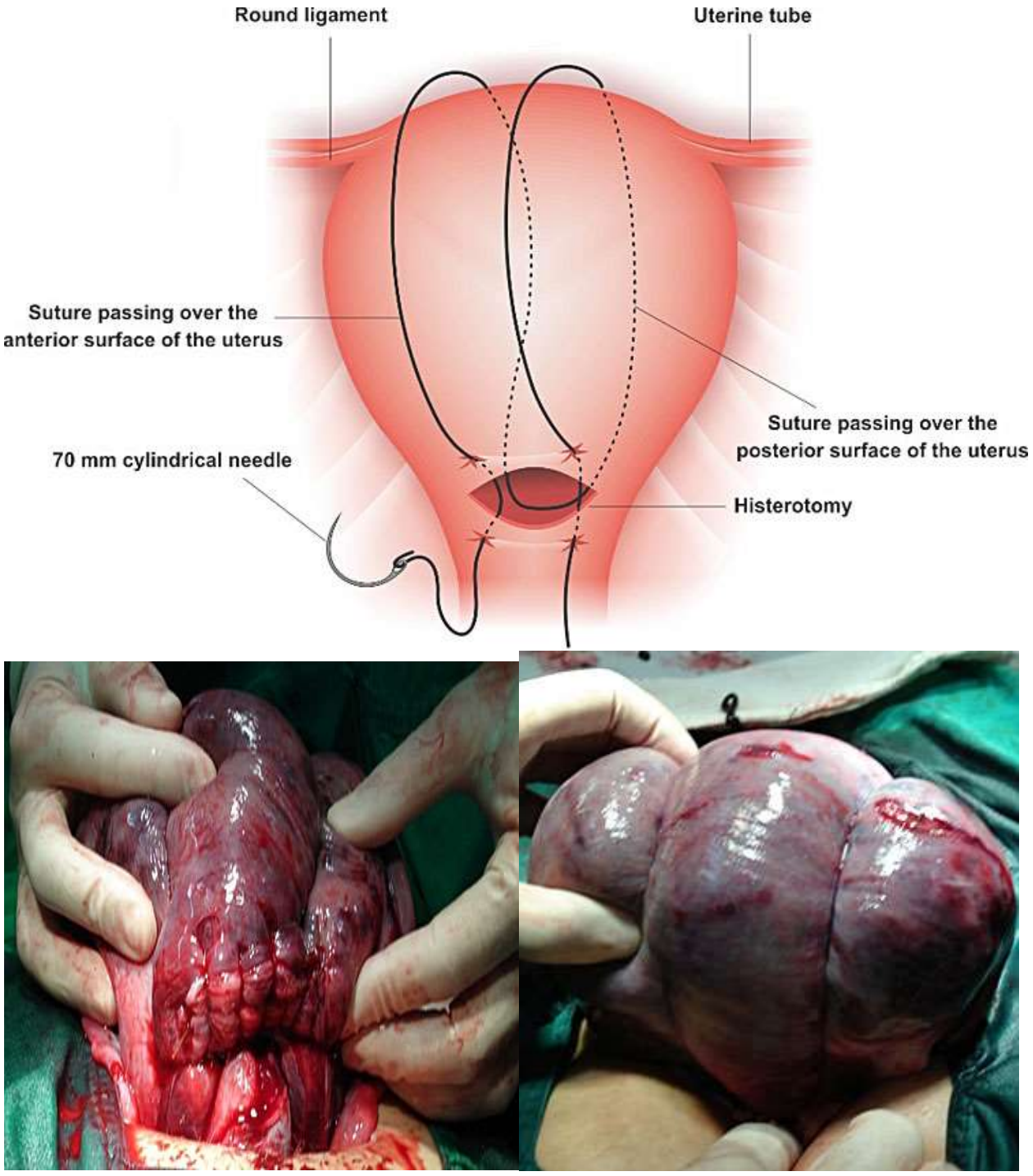
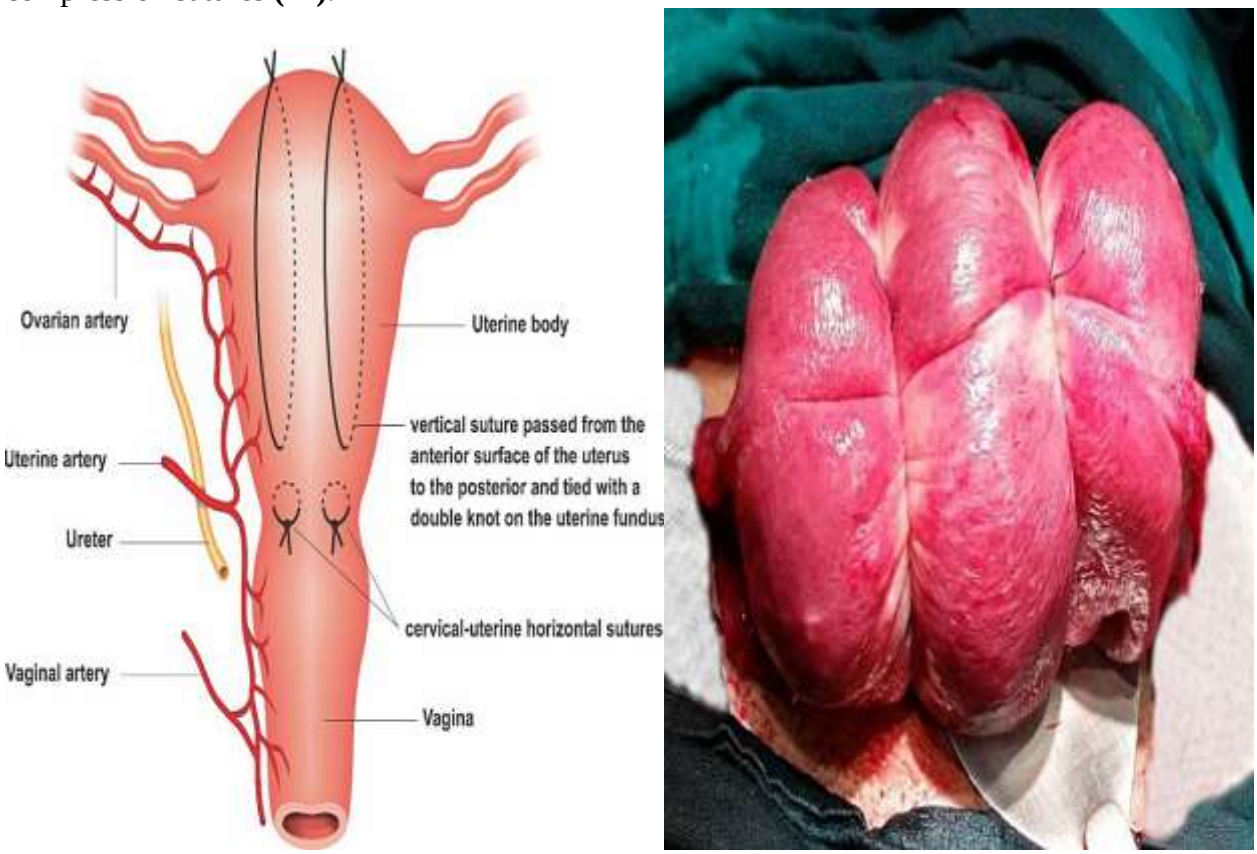


Figure B-Lynch anterior and posterior view. B-Lynch suture technique: a stitch is placed 3 cm below the hysterotomy incision and threaded through the uterine cavity to emerge 3 cm above the upper incision margin. The suture is then carried vertically over the top of the uterus and to the posterior side of it. The stich now enters into the cavity at the level of the hysterotomy incision and the uterosacral ligament. With the suture inside the cavity, it is carried horizontally to the corresponding position on the other side of the uterus. The needle now transfixes the uterus from inside to the outer surface of the uterus. The suture, which is now outside of the uterine cavity posteriorly, will do the same suture initial steps, but in inverse sequence. Finally, the needle picks up the anterior wall at the same level as the initial entry point, and the thread is tied. Below, the anterior and superior views of the B-Lynch suture applied in Couvelaire's uterus **(9)**.

Hayman compressive suture

Hayman compressive suture resembles the B-Lynch technique in terms of success rate and indications. The main difference is that the two arm sutures are inserted into the anterior wall to the posterior, without hysterotomy. Hayman's suture can also be performed using four longitudinal threads (instead of two) and, if a bleeding from lower uterine segment co-exists, it recommends the application of two isthmic-cervical compression sutures **(12)**.



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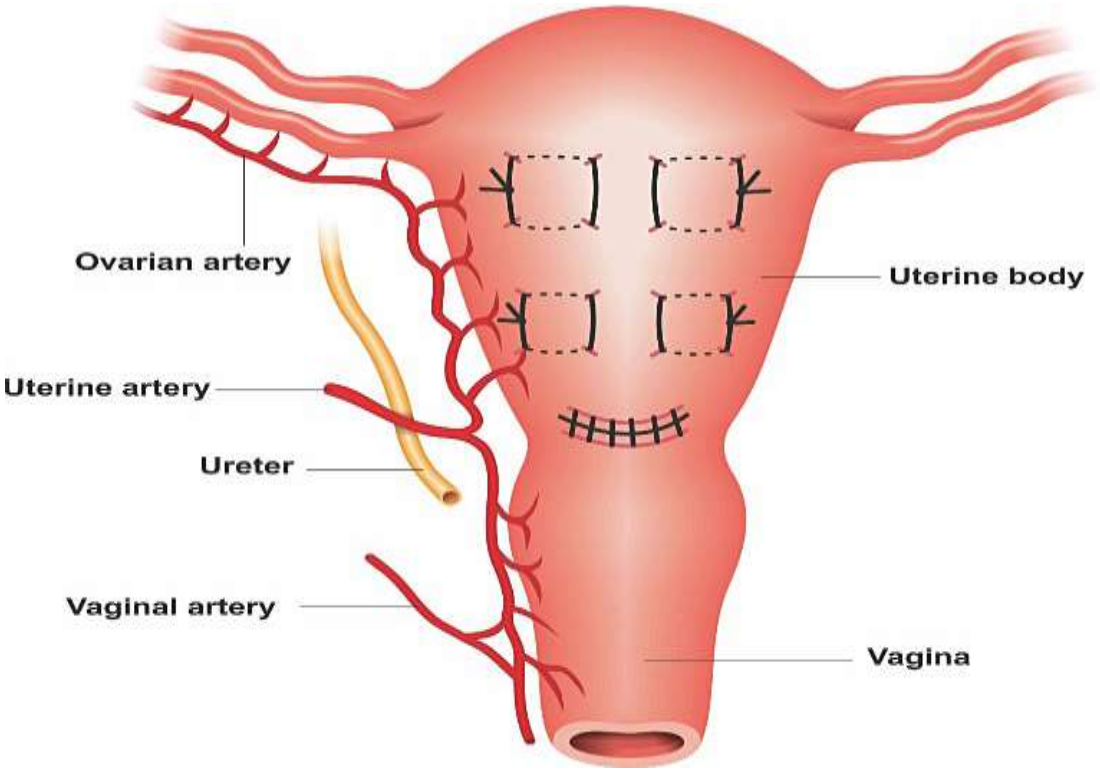
(A) Hayman suture anterior view. The needle transfixes the whole thickness of both uterine walls at the lower uterine segment level, with the thread being passed over to compress the fundus, and the thread tied at the fundus. The same is done on the opposite side. If bleeding from the lower uterine segment co-exists, two transverse cervicoisthmic sutures should be made. It does not need hysterotomy. (B) the superior view of Hayman's uterus suture after uterine atony **(13)**.

Cho compressive suture

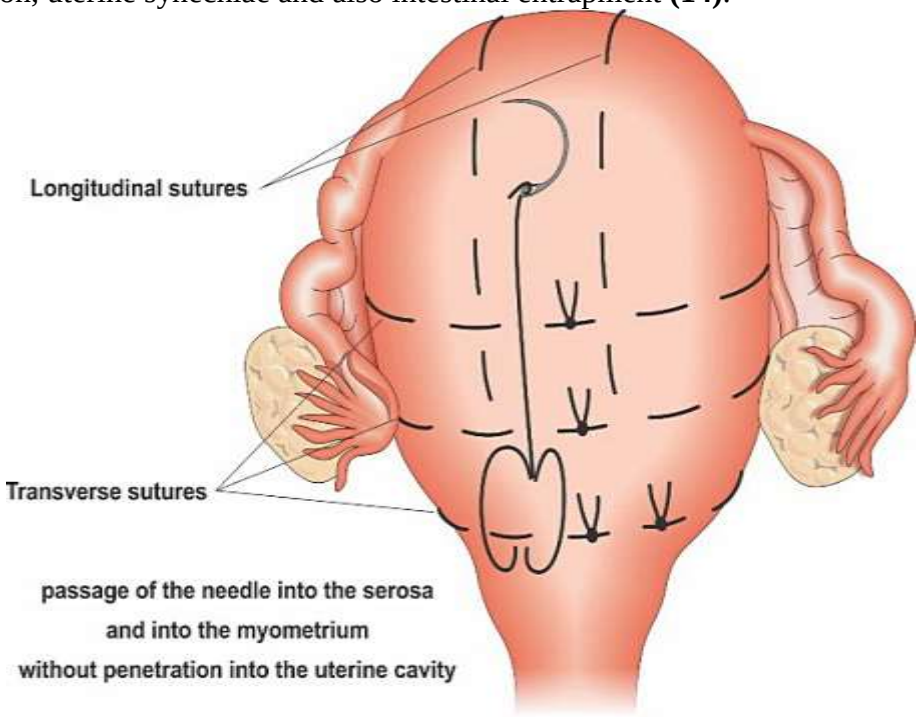
Cho procedure is the "square" suture technique. It eliminates the spaces inside the uterine cavity, joining the anterior and posterior walls. It is useful for bleeding sites located in the body and lower segments of the uterus. Some authors, when applying Cho's sutures dilate the cervix so as to avoid hematometra. In an atonic uterus, four to five square sutures should be made (from the fundus to the uterine segment). In cases of placenta acreta the squares are applied in the bloodiest areas. In the placenta previa, the squares approach the walls of the uterine segment after bladder is displaced inferiorly **(13)**.



Cho suture anterior view. Technique: a needle transfixes the uterus from anterior to posterior wall and then from posterior to anterior. The same is done to approximate the anterior and posterior uterine walls in a "square" manner **(14)**.

Pereira compressive suture

The Pereira technique is a non-penetrating multiple transverse and longitudinal suture. The uterus is involved by several continuous sutures without penetrating the uterine cavity .This technique may reduce the risks of infection, uterine synechiae and also intestinal entrapment **(14)**.



Pereira suture anterior view **(14)**.

Technique: placement of the sutures involved a series of bites inserted superficially, taking only the serous membrane and the subserous myometrium without penetrating the uterine cavity. When the suture crossed the broad ligament, it is important to select an avascular area and to be sure that the fallopian tube, the utero-ovarian ligament, and the round ligament are not inside the suture **(14)**.

OTHER UTERINE COMPRESSIVE SUTURES TECHNIQUES

Many other techniques have been described that can be useful. Most of them were developed to overcome the disadvantage or the complications of the more traditional UCS. Some techniques may also associate compressive sutures to other hemostatic procedures, such as uterine artery ligature or intrauterine tamponade balloon **(15)**.

Matsubara-Yano compressive suture

The Matsubara-Yano (M-Y) suture was developed to overcome some B-Lynch's suture drawbacks, such as the need to perform hysterotomy and the possibility of B-Lynch braces "slides off". The M-Y suture transfixes uterine lower segment from anterior to posterior and then transfixes the uterine fundal edge from posterior to anterior, with the thread tied (longitudinal suture). After it, two transversal sutures are performed (crisscrossing suture). Hysterotomy is not necessary. A modified M-Y technique can also be associated to the use of intrauterine tamponade balloon in cases of placenta previa . This association is also known as M-Y sandwich technique. As can be observed, there are only two transversal sutures (instead of the three proposed by the original technique). M-Y sutures may be useful to avoid recurrence of uterine inversion **(16)**.

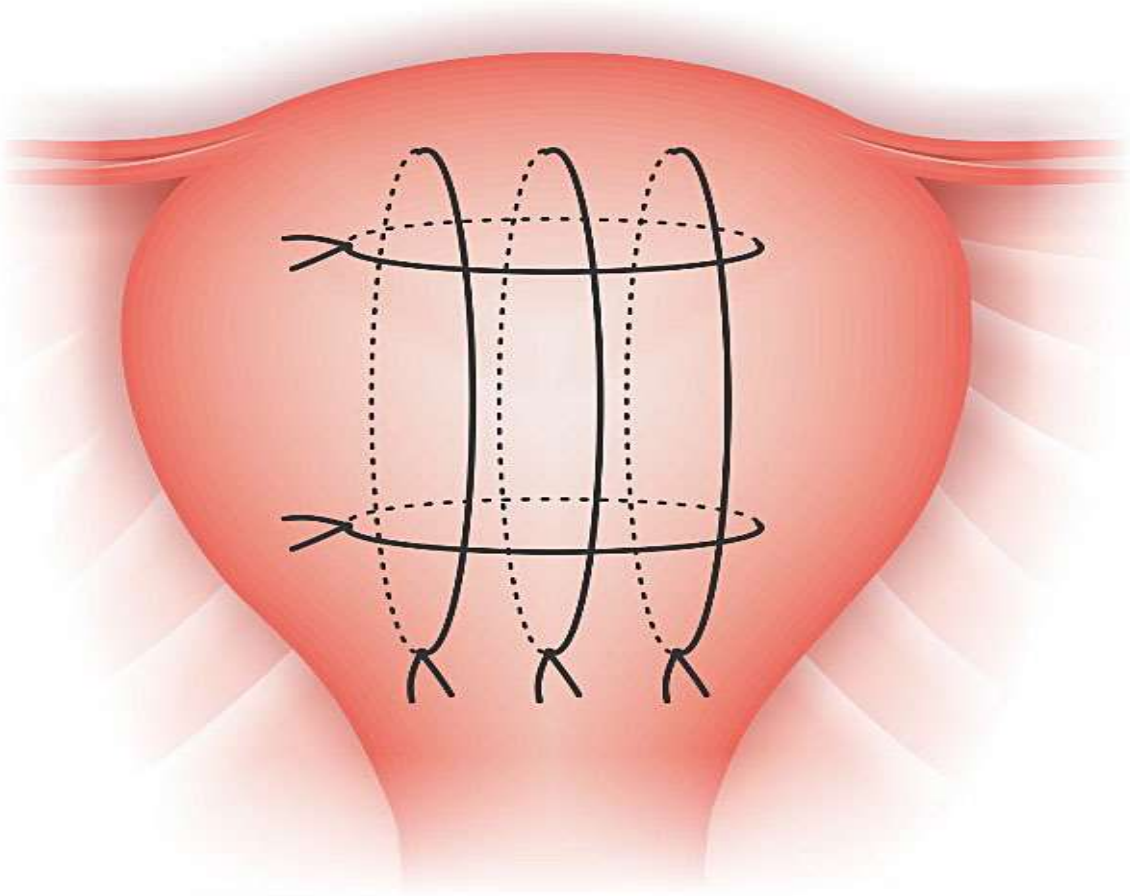


Figure.1 anterior view of the original Matsubara-Yano (M-Y) suture **(17)**.

Dedes compressive suture

Dedes procedure is an effective circular isthmic-cervical compressive suture developed to treat cases of PPH due to placenta previa/acreta during a cesarean section. This technique interrupts blood circulation from the cervical artery and the branches of the vaginal artery; and keeps the cervix contracted. To avoid ureter and bladder injury, the bladder should be reflected downwards. A silastic drain (e.g. Foley catheter) is inserted into the internal and through the external os, so as to drain the uterine cavity and to keep the cervical canal open **(18)**.

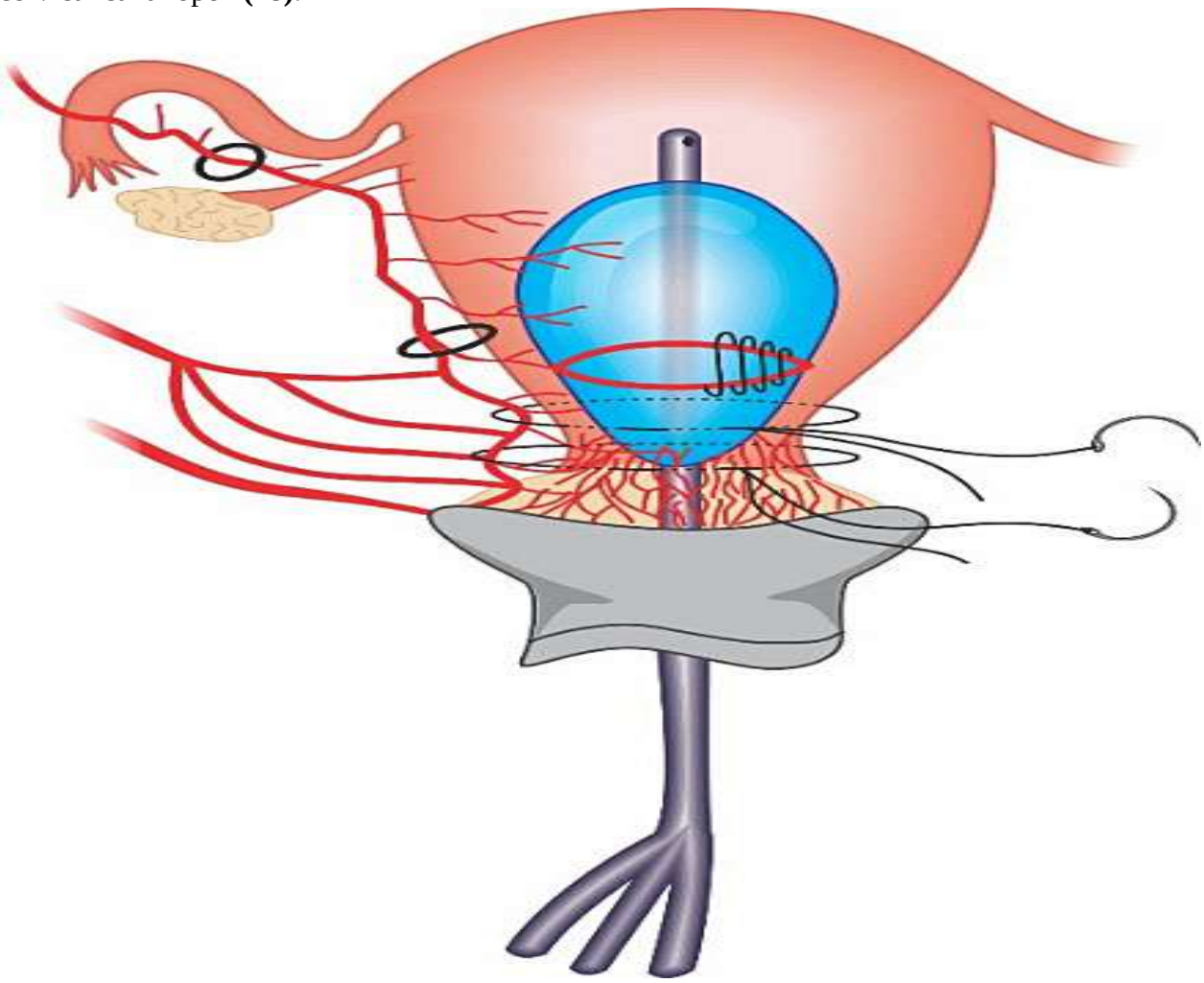
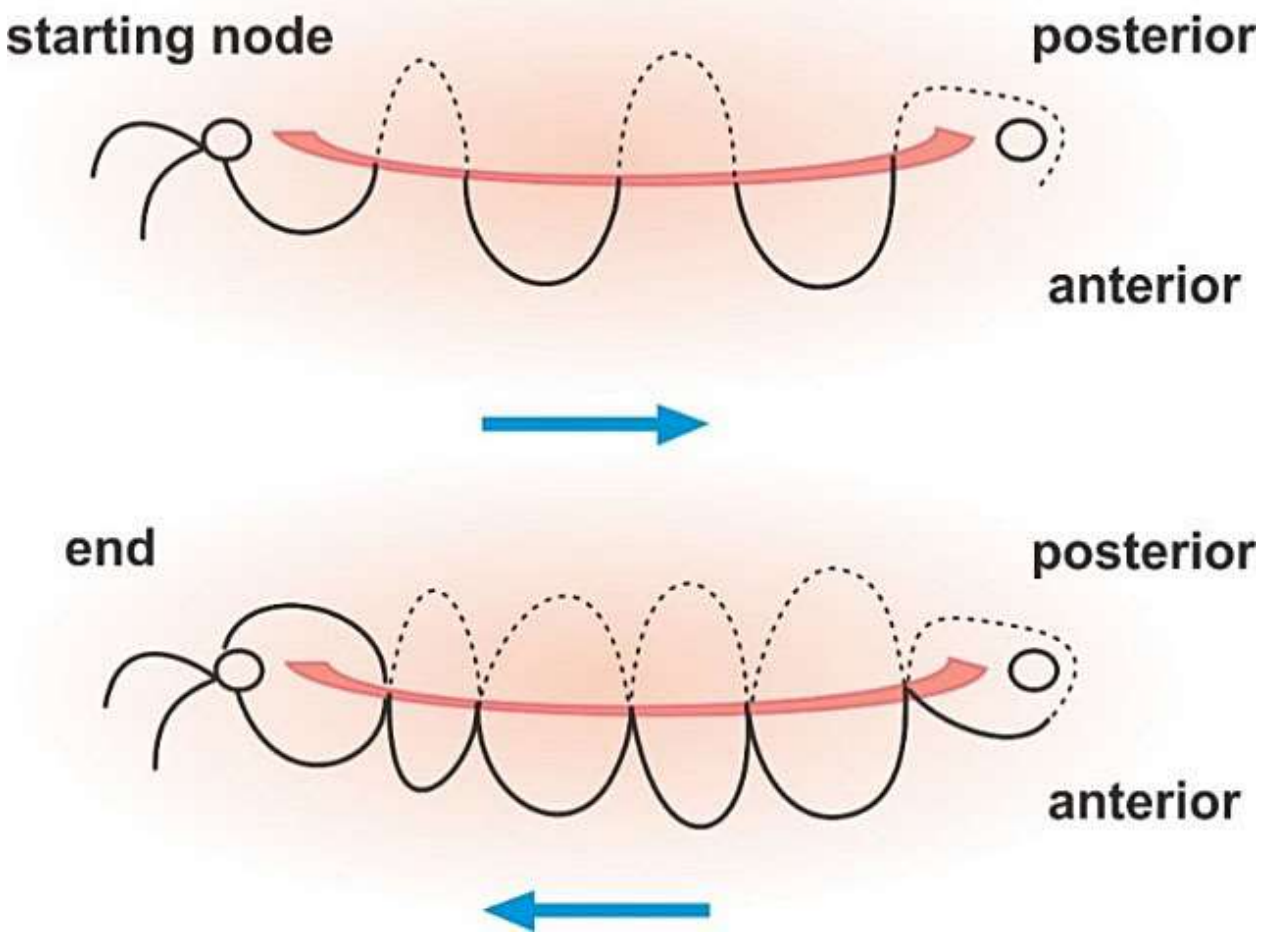


Figure.2 Dede compressive suture anterior vision: a circular isthmic-cervical compressive suture associated to a Foley catheter inserted into the cervical orifice to maintain drainage of the uterus cavityClick or tap here to enter text..

Multiple 8 compressive suture

The multiple compression suturing was described by Shazly (19) as an additional procedure to control hemorrhage and preserve fertility in patients with placenta acreta. This procedure was performed after the bilateral uterine ligature and failed to stop the hemorrhage from anterior wall of the lower uterine segment. This technique may also be useful in cases of placenta previa **(19)**.



Figure(3) Technique of transverse lower uterine segment compression suture **(8)**.

II. PELVIC VASCULAR SUTURES

Pelvic vascular sutures (PVS) consist of selective ligatures of major pelvic vessels that nourish the pelvis, in order to reduce blood supply in a bleeding area. It usually does not treat the cause of PPH, instead of this, it reduces the perfusion pressure while definitive treatment is being performed. In some situations, it may be sufficient to control hemorrhage. PVS as well as UCS should be easily performed to quickly and safely control the bleeding since patient's conditions may be aggravated by the delay in definitive treatment. To perform PVS, it is essential to know the origin, distribution and anastomosis of the genital arterial pedicles that are being ligated. The vessels most commonly addressed are the uterine arteries, the ovarian arteries, the round ligaments arteries and the internal iliac arteries. To guarantee the ligature efficacy, it is essential to monitor the persistence of bleeding during surgery. If bleeding persists, the healthcare provider should move to next step of PPH treatment (frequently hysterectomy) **(8)**.

Bilateral uterine artery ligature

A commonly technique consists of a suture 2–3 cm below and lateral to the segmental region of the hysterotomy . It is important to guarantee that bladder is away from the placement of the suture to avoid ureteric or bladder injury. The suture should encompass both the uterine artery and vein. It can be performed in association with compressive sutures or with other major pelvic vessels (such as ovarian artery). The ligature's hemostatic effect will be observed right after the procedure. The uterus will become pale, with a pinkish hue, and bleeding will subside. The uterus may not become firm, but only less softened than before. The uterus will sometimes contract. Uterotonics (e.g. oxytocin) should be maintained in cases of uterine atony **(19)**.

The BUAL optionally may be performed vaginally, through a 2-cm horizontal incision that is made in the anterior cervix, 1 cm beneath the vaginal cervical fold and the bladder reflected in the natural plane. After it, the uterine arteries are bilaterally accessed and ligated. The vaginal uterine artery ligation however may have more complications **(20)**.

Ligations of the ovarian arteries

The ovarian artery is usually performed when BUAL has failed to control the bleeding or in association with it. They are also useful for the treatment of bleeding from the uterine fundus and/or the upper portions of the uterine body. The ovarian artery has an anastomosis with the ascending branch of uterine artery, and corresponds to the other 10% of vascular irrigation of the uterine body. The ovarian arteries ligatures should be performed close to the level of the uterine-ovarian ligament (below or above it). Its complications are usually related to accidental ureter ligature, lesions of surrounding structures or even ovarian failure **(21)**.

Ligations of the internal iliac arteries

Internal iliac artery ligation (IIAL) is indicated when there is an intractable hemorrhage, in an effort to reduce it. IIAL is more complex and so requires more surgical skills when compared to the other ligations. Due to a high level of anastomosis to the uterus and pelvis, some professionals do not use this technique frequently. Also IIAL needs more time to be performed, prevents further use of endovascular therapy (by closing the main access to pelvic branches) **(21)**

IIAL requires an abdominal approach. The uterus must be externalized and the broad ligament should be opened under the infundibulopelvic ligament. The bifurcation of the iliac trunk is identified and the hypogastric artery (internal iliac) is dissected over a distance of 3 cm, widely opening the vascular sheath to limit the risk of venous injury. After systematic identification of the ureter, a ligature is placed using a ligature passer about 2–3 cm below the bifurcation, taking care not to injure the vein . At the end of the procedure, we check the pulsations of the external iliac artery. The complications related to it can be infertility, buttock and thigh claudication, damage to the ureter, ischemic limb from damage to common or external iliac artery, damage to other pelvic vessels, damage to pelvic nerves, including the hypogastric plexus. The rate of complications may depend on the experience of the surgeon **(22)**.

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