EDITORIAL

Uterus-sparing interventions to treat postpartum hemorrhage during cesarean delivery surgery

Cesarean delivery is often associated with postpartum hemorrhage. Frequent use of uterine-sparing interventions can help reduce total blood loss.

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Postpartum blood loss greater than 1,000 mL occurs in approximately 7% of cesarean delivery (CD) procedures with the administration of oxytocin alone or oxytocin plus misoprostol.[1] Rapid identification and control of hemorrhage is essential to avoid escalating coagulopathy and maternal instability. In cases of excess blood loss, clinicians request assistance from colleagues, endeavor to identify the cause of the bleeding, utilize additional uterotonics (methylergonovine, carboprost, misoprostol), perform uterine massage, warm the uterus, repair lacerations and replace blood products. If blood loss continues after these initial measures, obstetricians may consider uterine artery embolization (UAE) or hysterectomy. While UAE is a highly effective measure to control postpartum hemorrhage, it is not available at all obstetric hospitals. Even when available, there may be a significant time delay from the decision to consult an interventional radiologist to completion of the embolization procedure.

To avoid the permanent sterilization of a hysterectomy, or to obtain time for UAE or correction of coagulopathy, additional uterus-sparing surgical interventions should be considered. These include: 1) progressive uterine devascularization, 2) uterine compression sutures, and 3) intrauterine balloon tamponade. One caveat is that there is very little high-quality evidence from randomized trials to compare the efficacy or outcome of these uterine-sparing surgical interventions. Most of our evidence is based on limited case series and expert recommendations.

Uterine devascularization

Many techniques have been described for performing progressive uterine devascularization. Most experts recommend first performing an O'Leary suture, ligating both ascending uterine arteries and accompanying veins at a point approximately 2 cm closer to the cervix than the uterine incision (**FIGURE 1**). An absorbable suture is passed through the myometrium, being sure to remain medial to the ascending uterine vessels. Clear visualization of the vessels posteriorly is essential, usually necessitating exteriorization of the uterus. The needle is then driven through an avascular space in the broad ligament close to the uterine vessels, and the suture is tied down. Ureteral injury can be avoided by extending the bladder flap laterally to the level of the round ligament and mobilizing the vesicouterine peritoneum inferiorly, with the suture placed directly on endopelvic fascia. If necessary, the utero-ovarian ligament can be ligated in a second step, just below the uterine-tubal junction. The progressive devascularization intervention can be limited to the first or second steps if bleeding is well controlled.

In our experience, bilateral O'Leary sutures are highly effective at controlling ongoing uterine bleeding, particularly from the lower

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uterine segment. In the event that they are not successful, placement does not preclude later use of UAE.

Uterine compression sutures

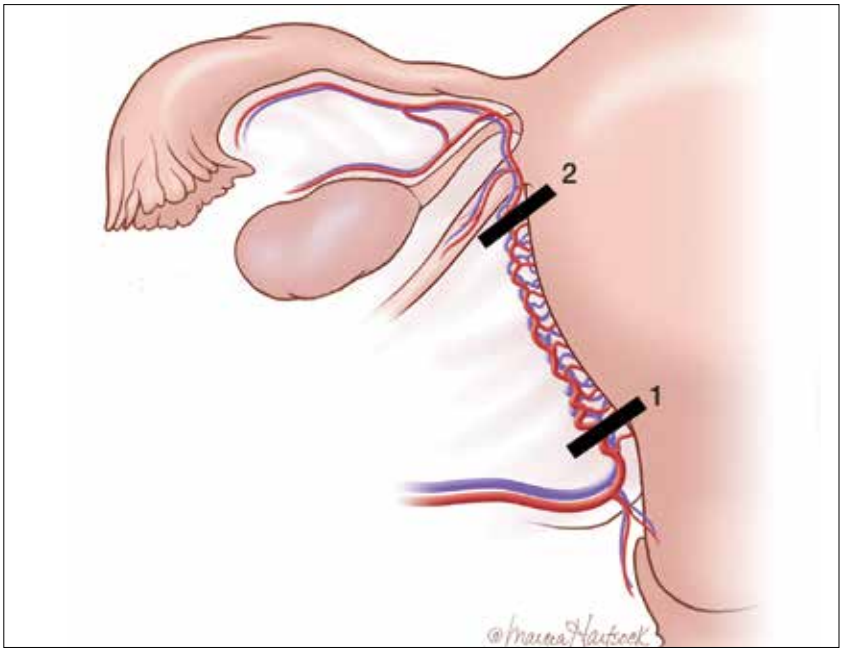
Compression sutures are most often used in the setting of refractory uterine atony. They also may be helpful for controlling focal atony or bleeding from a placental implantation site. More than a dozen different types of uterine compression sutures have been reported in the literature; the B-Lynch, Hyman, and Pereira sutures are most commonly performed.[2]

The B-Lynch suture[3] is performed with a long, rapidly absorbable suture on a large needle (**FIGURE 2,** page 6). We use a 60-inch #1 or #2 chromic suture on a TP-1 needle in the following steps:

1. Take bites on either side of the right edge of the hysterotomy incision (A and B). Place these bites approximately 3 cm from the edge of the hysterotomy incision.
2. Loop the suture around the fundus and reenter the uterus through the posterior uterine wall at point C, which is directly posterior to point B.
3. Exit the posterior wall of the uterus through point D.
4. Loop the suture over the uterine fundus.
5. Anchor the suture in the lower uterine segment by taking bites on either side of the left edge of the uterine hysterotomy incision (points E and F).
6. Pull the two ends of the suture tight while an assistant squeezes the uterus to aid compression.
7. Place a surgical knot to secure the suture.
8. Close the hysterotomy incision.

The B-Lynch suture was described with an open hysterotomy incision,[3] which avoids closing off the lower uterine segment. We have successfully performed a modification on a closed uterus, taking care to not drive the lower uterine sutures through both the anterior and posterior walls.

FIGURE 1 Sequential uterine devascularization sutures



Suture #1 is the O'Leary suture. Suture #2 reduces blood flow to the uterus from the vessels associated with the round and utero-ovarian ligaments.

The Hayman suture[4] was proposed with two important modifications: The suture is placed through-and-through the lower uterine segment with a closed hysterotomy, and the suture can be fixed to the uterine fundus to avoid slippage. This vertical compression suture (**FIGURE 3,** page 7) is performed by placing two to four vertical #2 chromic sutures directly through the anterior to posterior uterine wall, tying the suture on the fundus using a 3-throw technique to minimize slippage of the first knot. In the original description, Hayman also described injecting carboprost into the uterine fundus to stimulate uterine contraction and regularly inspecting the vagina to evaluate the extent of continued bleeding.[4]

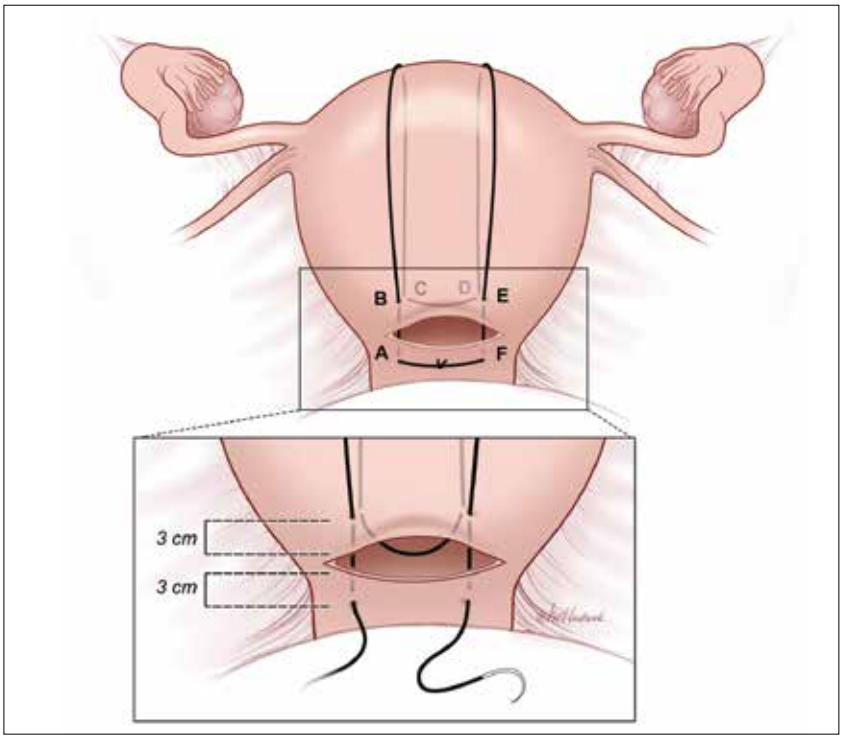
The Pereira sutures,[5] also described on a closed uterus, combine vertical and horizontal sutures placed as a series of bites into the submucosal myometrium using #1 polyglactin 910 (Vicryl) sutures (**FIGURE 4,** page 7). The sutures do not enter the uterine cavity. Two to three transverse sutures are initially placed followed by two vertical sutures. When placing the transverse sutures, it is important to cross the broad ligament in an avascular area and avoid trauma to blood vessels, ureters, gonadal vessels and fallopian tubes. The vertical sutures begin and end at the level of the transverse suture closest to the cervix.

Intrauterine balloon tamponade

Many types of balloon tamponade devices have been developed, ranging from the humble condom tied to a Foley urinary catheter to the

ILLUSTRATION: MARCIA HARTSOCK FOR OBG MANAGEMENT

FIGURE 2 B-Lynch suture



B-Lynch suture as seen from the anterior uterine wall.

sophisticated Bakri[6,7] and Belfort-Dildy[8] balloon tamponade devices. Intrauterine balloon tamponade is highly effective in controlling excess bleeding following vaginal delivery and less effective when used following a CD. In one study of 226 women with postpartum hemorrhage treated with a Bakri balloon the success rate was 89% and 66% following vaginal delivery and CD, respectively.[9]

When using balloon tamponade during a CD, some experts recommend partially closing the transverse hysterotomy incision by placing sutures to close edges of the hysterotomy, followed by insertion of the balloon into the uterus and the stem through the cervix into the vagina. Attachment of the stem to a collection bag should help to quickly assess the rate of blood loss. The balloon is inflated after the hysterotomy is closed. Following inflation of an intrauterine balloon, blood loss should decrease almost immediately.[10] If excessive blood loss continues for more than 10 minutes, additional uterus-sparing interventions or hysterectomy may be required. Following successful balloon tamponade, the balloon may be deflated 12 to 24 hours postpartum when maternal stabilization and normal coagulation have been achieved. If bleeding resumes, the balloon may be reinflated and UAE should be considered.

Combined interventions: Uterine devascularization plus uterine compression sutures

There are no high-quality randomized trials comparing the devascularization plus compression sutures versus a single intervention alone, and case series and case reports on this topic are lacking. If uterine devascularization alone does not sufficiently control bleeding, adding a uterine compression stitch might resolve the hemorrhage. Both procedures require only suture material, which is immediately available in all operating rooms. Hence, this combination of interventions can be executed quickly.

Uterine sandwich: Intrauterine balloon tamponade plus uterine compression sutures

CD for placenta previa is associated with an increased risk of postpartum hemorrhage, with bleeding from the lower uterine segment greatly contributing to total blood loss. While O'Leary sutures can stem the flow of bleeding in this area, the use of both an intrauterine balloon tamponade plus uterine compression sutures—a so-called uterine sandwich—may result in maximal reduction in blood loss.[11,12]

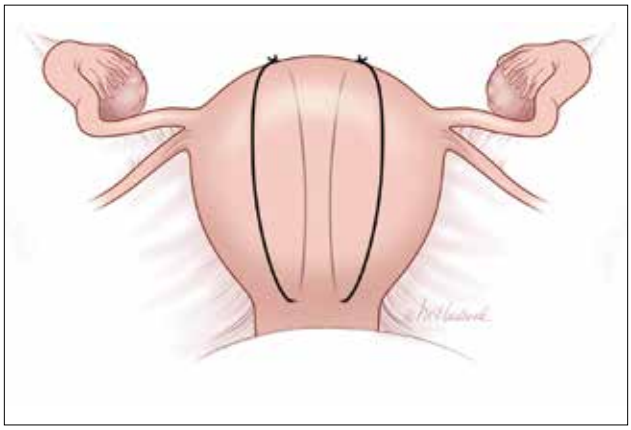
In one randomized trial, 106 women undergoing CD for a placenta previa were randomly assigned to uterine devascularization alone or double transverse compression suture at the lower uterine segment plus intrauterine Foley catheter balloon. Compared with women receiving devascularization alone, the combination of compression suture plus intrauterine balloon significantly reduced blood loss (1,350 mL vs 750 mL, respectively; $P = .0001$).[13]

Underutilization of uterine-sparing interventions

In a nationwide study of 50 consecutive Danish peripartum hysterectomy cases, an audit committee concluded that 24% of the hysterec-

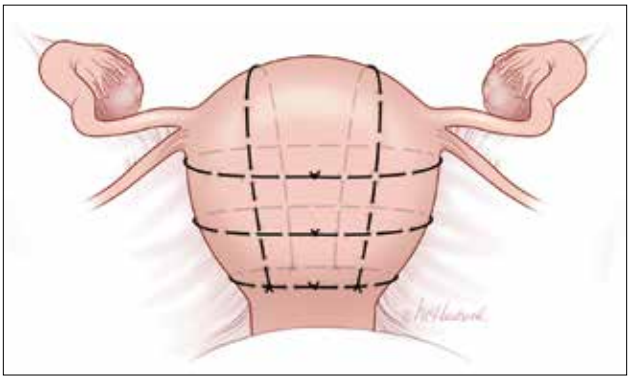
ILLUSTRATIONS: MARCIA HARTSOCK FOR OBG MANAGEMENT

FIGURE 3 Hayman suture



The Hayman suture passes directly from the anterior uterine wall through the posterior uterine wall. Two to four longitudinal sutures can be placed. Two longitudinal sutures are pictured in this figure. A transverse cervicoisthmic suture also can be placed, if needed, to control bleeding from the lower uterine segment.

FIGURE 4 Pereira sutures



The Pereira sutures combine longitudinal and transverse sutures placed as a series of bites into the submucosal myometrium. The sutures do not enter the uterine cavity. The longitudinal sutures begin and end at the level of the transverse suture closest to the cervix. Avoid damage to blood vessels and the ureters when placing the transverse sutures. Two longitudinal sutures and three transverse sutures are pictured in this figure.

tomies could have been avoided, and an additional 30% of hysterectomies might have been avoided, if uterine-sparing surgical interventions had been utilized.[14] In a recent survey of senior ObGyn residents in France, greater than 70% of respondents reported that they had not mastered uterine-sparing techniques of uterine devascularization and compression sutures, nor peripartum hysterectomy.[15] Together, these studies suggest that uterine-sparing interventions are underutilized and that with more training and practice clinicians would become facile with these interventions.

The cornerstones of uterine-sparing surgical interventions are simplicity, safety, and efficacy. If a combination of pharmacologic and ***multiple*** uterine-sparing surgical interventions do not control the bleeding, the patient may need an emergency hysterectomy or, if stable, a UAE. While devascularization and compression sutures are described during CD, it is reasonable to use them after vaginal delivery if the next reasonable step would be a laparotomy. When you next face the clinical challenge of a postpartum hemorrhage, rapid recognition of excess blood loss, early identification of the cause, swift pharmacologic treatment, and timely escalation of surgical interventions will help you reduce the risk of hysterectomy and severe maternal morbidity. ●

References

1. Gallos ID, Papadopoulou A, Man R, et al. Uterotonic agents for preventing postpartum haemorrhage: a network meta-analysis. *Cochrane Database of Syst Rev*. 2018;12:CD011689.
2. Li GT, Li XF, Wu BP, et al. Three cornerstones of uterine compression sutures: simplicity, safety, and efficacy. *Arch Gynecol Obstet*. 2015;292:949-952.
3. B-Lynch C, Coker A, Lawal AH, et al. The B-Lynch surgical technique for the control of massive postpartum hemorrhage: an alternative to hysterectomy? Five cases reported. *Br J Obstet Gynaecol*. 1997;104:372-375.
4. Hayman RG, Arulkumaran S, Steer PJ. Uterine compression sutures: surgical management of postpartum hemorrhage. *Obstet Gynecol*. 2002;99:502-506.
5. Pereira A, Nunes F, Pedroso S, et al. Compressive sutures to treat postpartum bleeding secondary to uterine atony. *Obstet Gynecol*. 2005;106:569-572.
6. Bakri YN. Uterine tamponade-drain for hemorrhage secondary to placenta previa-accreta. *Int J Gynaecol Obstet*. 1992;37:302-303.
7. Bakri YN, Amri A, Abdul Jabbar F. Tamponade-balloon for obstetrical bleeding. *Int J Gynaecol Obstet*. 2001;74:139-142.
8. Dildy GA, Belfort MA, Adair CD, et al; ebb Surveillance Study Team. Initial experience with a dual-balloon catheter for the management of postpartum hemorrhage. *Am J Obstet Gynecol*. 2014;210:136.e1-e6.
9. Revert M, Cottenet J, Raynal P, et al. Intrauterine balloon tamponade for management of severe postpartum hemorrhage in a perinatal network: a prospective cohort study. *BJOG*. 2017;124:1255-1262.
10. Condous GS, Arulkumaran S, Symonds I, et al. The "tamponade test" in the management of massive postpartum hemorrhage. *Obstet Gynecol*. 2003;101:767-772.
11. Nelson WL, O'Brien JM. The uterine sandwich for persistent uterine atony: combining the B-Lynch compression suture and an intrauterine Bakri balloon. *Am J Obstet Gynecol*. 2007;196:e9-e10.
12. Matsubara S, Kuwata T, Baba Y, et al. A novel "uterine sandwich" for haemorrhage at cesarean section for placenta praevia. *Aust N Z J Obstet Gynaecol*. 2014;54:283-286.
13. Sallam HF, Shady NW. A sandwich technique (N&H variation technique) to reduce blood loss during cesarean delivery for complete placenta previa: a randomized controlled trial. *J Matern Fetal Neonatal Med*. 2018:1-8.
14. Colmorn LB, Krebs L, Langhoff-Roos J; NOSS study group. Potentially avoidable peripartum hysterectomies in Denmark: a population based clinical audit. *PLoS One*. 2016;11:e0161302.
15. Bouet PE, Madar H, Froeliger A, et al. Surgical treatment of postpartum haemorrhage: national survey of French residents in obstetrics and gynecology. *BMC Pregnancy Childbirth*. 2019;19:91.