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REVIEW ARTICLE

Advanced strategies for hemorrhage management in cesarean sections an in-depth procedural guide

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Abstract

Over the past five decades, there has been a substantial global increase in cesarean section rates. Unfortunately, the incidence of maternal morbidity following cesarean delivery remains notably high, reaching levels as elevated as 36%. Among the prevalent complication sare febrile episodes (25%), hemorrhage (4%), hematoma formation (4%), and urinary tract infections (3%). Obstetric hemorrhage, in particular, stands out as a leading cause of maternal mortality worldwide. Excessive bleeding, defined as a blood loss exceeding 1000 ml during cesarean sections, is frequently underestimated, yet it is documented in over 5-10% of such procedures. While conservative management, including vaginal packing and the administration of uterotonic agents, is effective in many instances, persistent hemorrhage may necessitate specific surgical interventions. Therefore, a comprehensive understanding of the procedural steps form an aging bleeding during cesarean sections is crucial to mitigating maternal mortality. This review article aims to consolidate various techniques employed to control hemorrhage during cesarean deliveries.

Keywords: cesarean; hemorrhage; postpartum

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Introduction

In contemporary obstetrics, cesarean sections account for approximately 15% of all births worldwide, with significant disparities observed across different countries. Obstetric hemorrhage remains a predominant contributor to maternal morbidity and mortality. In the year 2000, an estimated 529,000 maternal deaths were recorded globally, predominantly in nations with limited resources. In developed regions, a woman's lifetime risk of maternal death is 1 in 2800, whereas in less developed areas, this risk escalates to 1 in 61. The proportion of these deaths attributable to hemorrhage varies by region, with it being the leading cause in Africa and Asia, accounting for 33.9% and 30.8% of maternal deaths, respectively. In wealthier nations, hemorrhage accounts for 13.4% of maternal fatalities. Postpartum hemorrhage (PPH) is typically defined as the loss of more than 500 milliliters of blood from the vaginal tract within the first 24 hours after childbirth. This definition poses challenges when applied to cesarean deliveries, as the average blood loss following an elective lower segment cesarean is approximately 500 mL, nearing this threshold. Although earlier data often cite 1000 mL as a reference point, recent studies have not extensively measured typical blood loss during emergency cesareans following labor. Risk factors for PPH during cesarean include general anesthesia, amnionitis, prolonged labor, pre-eclampsia, multiple gestations, fetal macrosomia, hematological disorders, pretermbirth, leiomyomas, placenta previa, and bleeding before or during labor [1].

This review article delinetes the step-by-step management of bleeding during cesarean sections, encompassing the use of medications, conservative and radical surgical techniques, and the application of abdominal packing to control hemorrhage.

Medical Treatment

The ideal uterotonic agent for cesarean sections should be straight forward to administer, exhibit minimal adverse effects, and effective lymitigate severe hemorrhage. In cesarean deliveries, both general and regional anesthesia are options, though general anesthesia is associatedwith an elevated risk of PPH. Currently, regional anesthesia is ominantly utilized for both elective and emergency cesareans in developed regions. Spinal anesthesia, in particular, may lead to maternal hypotension. Oxytocin is a commonly employed uterotonic; however, ergometrine can induce nausea and hypertension, while misoprostol may cause chills and fever, with its intraoperative administration posing challenges. The patient population undergoing cesarean sections displays considerable clinical variability, with the duration of labor prior to surgery significantly influencing the optimal prophylactic drug and dosage. Additionally, increased expression of oxytocin receptors in myometrial tissues as gestation progresses suggests that uterotonic response may vary significantly between early and term gestations[1].Antifibrinolytic agents, particularly tranexamic acid (TXA), have beendemonstrated to reduce blood loss and the necessity for transfusions during cesarean procedures [2].

The incorporation of TXA in to standard oxytocin prophylaxis during cesarean sections significantly reduces hemoglobin drop, postpartum blood loss, incidence of PPH and severe PPH, as well as the need for additional uterotonic agents and blood transfusions. Were commendad ministering 1 g (or 10 mg/kg) of TXA intravenously 10–20 minutes prior to skin incision or spinal anesthesia. This recommendation is based on TXA's proven efficacy and safety in preventing one of the most prevalentand severe complications of pregnancy. Furthermore, oxytocin is administered post-delivery of the neonate to further minimize blood loss during cesarean procedures [3].

Table 1 : Postpartum hemorrhage of risk assessment tool

LOW RISK	MEDIUM RISK	HIGH RISK
Singleton pregnancy	Prior ceserean or uterines urgery	placenta accretas pectrum
Unscarred uterus	Multiple gestation	Bleeding at admission
Absence of postpartum Hemorrhage history	Large uterine fibroids	Known coagulation defect
	Choriamnionitis	History of postpartum hemorrhage
	Prolonged use of oxytocin	

Surgery

Arterial Ligation

Ligation of the uterine and utero-ovarian arteries can decrease uterine hemorrhage by reducing perfusion pressure in the myometrium. Although it may not completely halt bleeding from placenta accreta spectrum or uterine atony, it can diminish blood loss while other interventions are implemented. This procedure does not appear to impair reproductive function or damage the uterus [4].

Ligation of the internal iliac (hypogastric) arteries is a complex procedure, even for experienced pelvic surgeons, especially in cases involving an enlarged uterus, limited visibility from a transverse lower abdominal incision, on going pelvic hemorrhage, or obesity. The challenges are compounded when attempting bilateral ligation due to infrequent operations in the deep pelvic retroperitoneal space. Consequently, this technique has largely been supplanted by uterine compression sutures, uterine artery ligation, and arterial embolization. Bilateral internal iliac artery ligation reduces the pulse pressure of uterine blood flow, but its efficacy may be compromised by large collateral vessels, such as in placenta percreta. There have been instances of reverse filling of the internal iliac arteries via branches of the external iliac artery, including the inferior epigastric, obturator, deep circumflex iliac, and superior gluteal arteries, beyond the ligation site [5].

B Lynch

Functions similarly to physical uterine compression by enveloping and compressing the uterus. It has been effective in arresting uterine bleeding due to atony in case reports and small series when other interventions have failed [6].While there is a potential risk of Asherman syndrome, the technique is relatively easy to learn, appears safe, preserves future reproductive potential, and does not increase adverse placentation outcomes in subsequent pregnancies. It is specifically indicated for uterine atony and is ineffective for hemorrhage associated with the placenta accreta spectrum. Additionally, it does not prevent postpartum hemorrhage in future pregnancies [7].

In the low eruterine segment, a large Mayo needle is used to insert and exit the uterine cavity with 1 or 2 chromic catgut sutures, or any absorbable suture if catgut is unavailable. Once the uterus is involuted, a robust suture is employed to prevent breakage, and rapid absorption is essential to avoid bowel herniation through the suture loop. The suture encircles the fundus, passes through the posterior wall, and re-enters the lower uterine cavity. It then traverses the anterior lateral lower uterine segment, crosses to the opposite side, exits through the posterior wall, and loops back over the fundus. Bimanual compression is applied as the suture ends retightened to compress the uterus. Proper patient positioning, such as legs apart or in a slight reverse Trendelenburg if stable, enhances the evaluation of chronic vaginal bleeding and the effectiveness of these interventions. This technique, sometimes used with balloon tamponade, is known as the “uterine sandwich” [8].

Pereira

Initially, Pereira sutures employed absorbableVicryl #1 with multifilament. Prior to the procedure, the likelihood of success is evaluated, with the patient positioned in a semi-lithotomy or Lloyd Davies position. The extent of bleeding is assessed, and bimanual compression is applied after externalizing the uterus. If bleeding ceases during compression, the application of Pereira sutures is deemed effective. The technique involves encircling the uterus with transverse and longitudinal sutures, using superficial bites that preserve the uterine cavity. Sutures are placed starting from the anterior aspect, with transverse sutures tie dover the anterior uterus and crossing the broad ligament. Care is taken to avoid the fallopian tubes, utero-ovarian, and round ligaments by selecting avascular regions. Longitudinal sutures are anchored by the final transverse suture, beginning dorsally and ending ventrally, ensuring secure compression [9].

Hayman

For managing atony after vaginal delivery, Hayman proposed the use of two to four vertical compression sutures placed from the anterior to the posterior uterine wall without performing a hysterotomy. If required, a transverse cervicoisthmic suture can be added to control hemorrhage in the lower uterine segment [10].

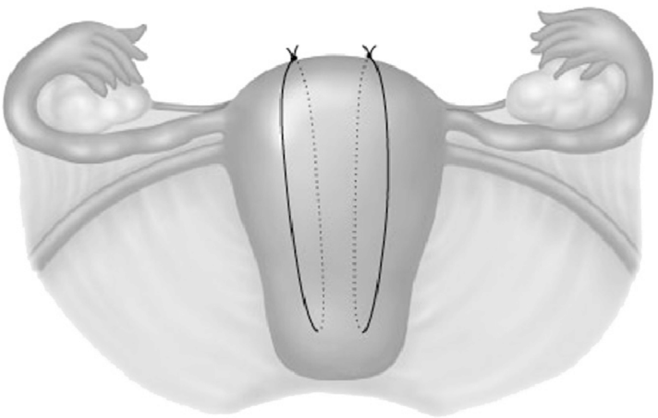

Figure 1 : Hayman Technique

Cho Technique

Cho's square suture technique involves compressing the endometrial cavity by passing a straight needle through bleeding sites. The needle is initially inserted between the anterior and posterior uterine walls, then reinserted from posterior to anterior 2-3 cm laterally. This process is repeated in the opposite direction, with the needle raised by 2-3 cm each time. The knot is tied securely to ensure hemostasis. This method, involving multiple square sutures, is effective in treating uterine atony following twin cesarean delivery [11].

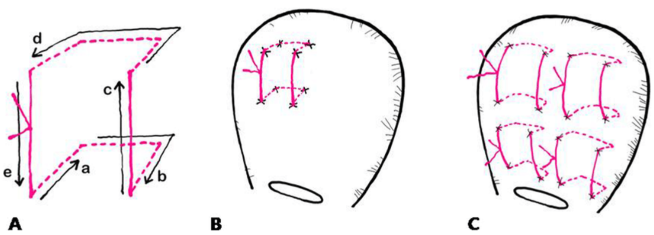

Figure 2 : Cho Technique

Matsubarayano

The B-Lynch suture presents several challenges. Initially, it requires a uterine incision or reopening of the cesarean scar, which must be performed immediately after placental delivery during a cesarean section. Although this allows for assessment of the uterine condition, it is an invasive procedure. Prompt closure of the cesarean incision is crucial to prevent delays caused by the B-Lynch suture, which can increas euterine contractions. Additionally, as noted by Hayman et al., the longitudinal sutures may "slide," potentially moving in to the uterine fundus and reducing peripheral compression. While Mondal et al. observed this issue with the Hayman suture, it can also occur with the B-Lynch suture due to their similar "brace" design. An excessively tight B-Lynch suture may cause "folding of the uterus," leading to in a dequate compression. Furthermore, the fundus may invert if the longitudinal suture exerts excessive cephalad pressure[12].

The MatsubaraYano (MY) suture addresses all four disadvantages of the B-Lynch suture. After securing the longitudinal suture, a needle is inserted from the anterior to the posterior lower uterine segment, and then from the posterior to the anterior uterine fundal edge. This process is repeated twice or thrice, forming two transverse sutures that intersect the longitudinal suture laterally. This configuration prevents the longitudinal suture from "sliding off", "sliding in", "bowing", or reinverting the uterine fundus. Compression sutures should be applied only after cesarean scars are removed or closed. In eight cases of PPH treated with MY suturing, complete hemostasis was achieved without short-term complications, and two patients subsequently became pregnant. Although B-Lynch et al. noted that their suture is straightforward, it can be challenging for inexperienced clinicians, particularly in emergencies requiring compression sutures. Hayman et al. also highlighted these challenges. The MY suture is easier to perform than the B-Lynch suture, emphasizing the principle of "applying pressure to the uterus"[12].

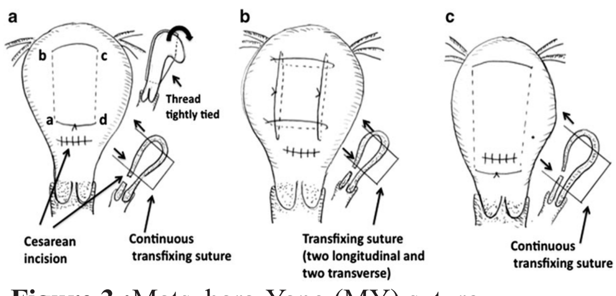

Figure 3 : Matsubara-Yano (MY) suture

Modified B-Lynchsuture

The Surabaya method employs a brace suture technique with three parallel longitudinal sutures using "Chromic catgut no.2" with straightened curved needles. The uterus is exteriorized, and an assistant pulls it to thin the lower uterine segment, facilitating needle passage from anterior to posterior. The first suture is placed approximately 2 cm below the cesarean incision at the medial-lateral margin, puncturing the posterior wall of the uterine isthmus. A second suture is applied contralaterally, and a third is positioned between the first two, each with a new suture. The operator tightens the sutures, securing the fundus 3 cm medial to the lateral edges and tying a third suture between them, while an assistant manually compresses the fundus to achieve an anteflexed-inferior position. A second assistant monitors the vagina; if no bleeding is observed, the abdominal wall is closed. If bleeding persists, further surgical intervention is required [13].

Hysterectomy

Hysterectomy remains the sole definitive treatment for persistent uterine bleeding. Regardless of the underlying cause of postpartum hemorrhage, significant blood loss can lead to severe coagulopathy. Complications such as acidosis, severe hypovolemia, hypothermia, tissue hypoxia, and electrolyte imbalances can exacerbate the patient's condition. If a laparotomy has not been performed, addressing these physiological deficiencies prior to hysterectomy is essential and may be life-saving. In cases of placenta accreta spectrum or uterine rupture, an early hysterectomy may be the least morbid approach, averting the risks associated with delayed intervention and ineffective fertility-preserving methods.

Advancements in prenatal detection of placental attachment issues now allow patients to anticipate and discuss the possibility of a hysterectomy with their physician prior to a scheduled cesarean delivery. Conversely, uterotonic drugs, either alone or combined with fertility-preserving interventions such as intrauterine balloon tamponade, uterine compression sutures, uterine artery or utero-ovarian artery ligation, and arterial embolization can typically manage uterine atony. Once resuscitation and coagulopathy reversal are achieved, a hysterectomy may not be necessary to control bleeding. However, if fertility preserving treatments fail to adequately manage the bleeding, a hysterectomy becomes imperative [14].

Abdominal Packing

Abdominal orpelviccompression can effectively arrest recurrent uterine bleeding by applying pressure to low-pressure veins and capillaries within the abdominal cavity, thereby reducing or halting hemorrhage. In cases of severe bleeding, patients may develop disseminated intravascular coagulation, acidosis, hypovolemic shock, and hypothermia. These conditions often associated with pregnancy complications, necessitate stabilization in an intensive care unit before further intervention. Abdominal packing, which mechanically compresses uterine vascular sinuses, is a rapid, efficient, and cost-effective hemostatic technique. Two primary methods for post-hysterectomy bleeding control include the use of pads or roller gauze (sterile pads secured by sutures or wrapped in sterile materials) and balloon packs (such as Foley catheters or Bakri balloons). The structural differences between these methods are notable: balloon packs can be quickly inflated and deployed, offering ease and speed of use, while pad packs require more complex set-up and attachment. Additionally, balloon packs allow for straightforward size adjustments to match hemorrhagic areas through inflation or deflation, whereas modifying a pad pack by adding or removing pads can be more cumbersome [15].

Conclusion

Obstetric hemorrhage continues to be a major contributor to maternal morbidity and mortality. Although historical data often cite a blood loss threshold of 1000 mL, recent studies have not adequately quantified typical blood loss during emergency cesarean sections following labor. Identified risk factors for PPH during cesarean delivery include general anesthesia, amnionitis, prolonged labor, pre-eclampsia, multiple gestations, fetal macrosomia, hematological disorders, preterm birth, leiomyomas, placenta previa, and bleeding before or during labor. Antifibrinolytic agents, particularly tranexamic acid (TXA), and the uterotonic agent oxytocin are employed to manage bleeding during cesarean sections, effectively reducing blood loss and the necessity for transfusions. Conservative surgical interventions include arterial ligation, such as the ligation of uterine and utero-ovarian arteries and internal iliac (hypogastric) artery ligation, as well as techniques like the B-Lynch, Hayman, and Cho methods. In cases requiring more radical intervention, procedures such as supravaginal hysterectomy may be performed. Additionally, abdominal or pelvic compression can effectively arrest recurrent uterine bleeding by compressing low-pressure veins and capillaries within the abdominal cavity, thereby reducing or halting hemorrhage.

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