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The pelvis houses an intricate network of arteries and veins that increase the potential for vascular injury and hemorrhage. The venous drainage is especially complex and variable, and venous walls are much more delicate than the muscular walls of arteries, rendering them more vulnerable to tears and laceration

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Catastrophic intraoperative hemorrhage: 5-step action plan

If this emergency cannot be averted with careful preoperative assessment, rely on a reasoned plan, basic tools, a few new tools, and tried-and-true techniques.

SALLY'S CASE

Placenta accreta leads to hemorrhage

Sally is a 27-year-old gravida with 1 prior cesarean whose ultrasound imaging is suspicious for "placenta adherent to the bladder." At 38 weeks, she delivers a viable infant by classical cesarean, at which time the ultrasound finding is confirmed: the placenta is densely adherent.

The placenta is left in situ, no methotrexate is given, and Sally is fol-

lowed with clotting studies and exams.

Eight weeks later, when her fibrinogen level falls and the prothrombin time and partial thromboplastin time become abnormal, the obstetrician attempts to perform dilatation and evacuation, but massive bleeding ensues. The physician then performs a total abdominal hysterectomy, but bleeding continues from the cuff.

What is the best way to manage the hemorrhage?

After identifying its source, the surgeon should apply pressure to abate the bleeding, using packing if necessary, and repair the affected artery or vein. Fortunately, we have many tools at our disposal, from preventive steps like careful preoperative assessment to the use of hemostatic agents, fibrin glues, hypogastric artery ligation, and specialized pelvic packing techniques. With prompt action and a stepwise approach, this bona fide catastrophe can usually be successfully managed. This article details a 5-step action plan.

If massive bleeding occurs during laparoscopic or vaginal surgery, a laparotomy may be indicated, and intraoperative management would follow the same 5 steps.

STEP 1

■ Like the Boy Scouts, be prepared

Although surgeons are acutely aware that drugs such as warfarin and heparin can cause intraoperative bleeding, the patient history and predisposing factors sometimes get short shrift.

Besides asking about the patient's medications, assess the following:

- **Platelets.** The primary laboratory test to evaluate potential bleeding is the platelet count. In general, 10,000 to 20,000 platelets are needed for hemostasis. However, 50,000 are needed for any surgery or invasive procedure, such as insertion of a central line.¹ I recommend platelet evaluation for patients scheduled for major abdominal surgery.
- **History of bleeding.** If the patient or her family has a history of bleeding with any surgery, evaluate her for von Willebrand's disease.
- **High alcohol intake** warrants preoperative liver function and coagulation studies.
- **Some herbal or natural remedies** can exacerbate intraoperative hemorrhage through their inhibition of coagulation, especially the agents listed in **TABLE 1**.

They should generally be discontinued 2 to 7 days before surgery.²

- **Aspirin and nonsteroidal anti-inflammatory drugs** should be discontinued 7 days before anticipated surgery. However, patients may continue aspirin at a daily dose of 81 mg.
- **Poor nutrition and obesity** predispose the patient to wound complications and intraoperative bleeding. Patients who are severely malnourished can take dietary supplements or receive total parenteral nutrition prior to surgery.
- **Intraoperative factors** such as the 3 "inadequacies" (inadequate incision, retraction, and anesthesia), low core body temperature, severe adhesions (ie, endometriosis), and large vascular tumors also are sometimes associated with bleeding.

For patients predisposed to bleeding, obtaining exposure is mandatory. Blood components and a cell-saving device also should be available, as described below.

STEP 2

■ Follow these basic principles

Whenever bleeding is encountered in any area of the abdominal cavity, the first step is simple: Apply immediate pressure with a finger or sponge stick. Then obtain exposure and assistance. Exposure usually means extending the incision and using a fixed table retractor.

If the source of bleeding is unknown, apply pressure on the aorta using a hand, weighted speculum, or Conn aortic compressor (*Pilling-branded, Teleflex Medical, Limerick, Pa*).

Secure individual vessels with fine-tipped clamps and small-caliber sutures or clips, and minimize the use of clamps. Never place clamps or sutures blindly, and never use electrocautery for large lacerations.

If you choose to use packs to temporarily control bleeding, insert them carefully to avoid tearing veins, and place pelvic packs (hot or cold) in a stepwise

FAST TRACK

If the bleeding source is unknown, apply pressure on the aorta using a hand, weighted speculum, or aortic compressor

TABLE 1

Alternative remedies that may exacerbate bleeding

- 32% to 37% of Americans use these remedies, but only 38% of them tell their doctor
- Stop all alternative remedies 2 to 7 days before surgery

REMEDY	USED FOR	PERIOPERATIVE RISKS
Beta-carotene	Vitamin A precursor; often taken as a nutritional supplement	May cause coagulopathy
Feverfew	Used to prevent or treat migraine and ease menstrual cramps	May inhibit coagulation
Fish oil	Rich in omega-3 fatty acids, recommended for cardiovascular health	Omega-3s inhibit coagulation
Garlic	Used to reduce hypertension and high cholesterol	Case reports of unexpected or increased surgical bleeding, prolonged bleeding time, and impaired platelet aggregation
Ginkgo	Treatment of dementia, impaired cognition, and memory	Various ginkgolides have platelet-activating-factor antagonist properties; case reports of spontaneous bleeding
Ginseng	Widely used as a stimulant, tonic, diuretic, mood elevator, and energy booster	May cause hypertension, cardiovascular instability, coagulopathy, and sedation
St. John's wort	Antidepressant	May cause cardiovascular instability, coagulopathy, and sedation
Vitamin E	Antioxidant	May interfere with coagulation

FAST TRACK

You have to ask. Alternative remedies can impair coagulation—and over 60% of people taking them do not tell their doctor

fashion, from sidewall to sidewall. Leave packs in place for at least 15 minutes and remove them sequentially.

Great vessel injuries

The aorta, vena cava, and common iliac vessels are sometimes injured during removal of paraaortic nodes or when the inferior mesenteric vessels are avulsed during retraction of the sigmoid colon. In addition, needle or trocar injuries during operative laparoscopy occur in as many as 4 of every 10,000 procedures.³

Again, the first step in managing great vessel injuries is applying pressure. Then obtain blood components, and, if necessary, consult with a vascular surgeon or gynecologic oncologist.

In general, once the patient is hemody-

namically stable, the affected vessel should be compressed proximally and distally. Use Allis or vascular clamps on the torn edges to elevate the lacerated area. My preference is to close these injuries with a running 5-0 or 6-0 nylon or monofilament polypropylene (MFPP) suture on a cardiovascular needle.

Replacing blood and its components

Be aware of the following replacement guidelines for catastrophic intraoperative hemorrhage:

- For every 8 U of red blood cells replaced, give 2 U of fresh frozen plasma.
- If more than 10 U of red blood cells are replaced, give 10 U of platelets, preferably at the end of the procedure.

CONTINUED

TABLE 2

Topical intraperitoneal hemostatic agents

AGENT	WHAT IT IS	HOW IT IS APPLIED
Avitene Ultrafoam	Absorbable collagen hemostat	Comes in powder; sprinkle on area
Fibrin glue • Coseal • Floseal • Tisseal	Equal amounts of cryoprecipitate and thrombin	Spray on affected area with double-barrel syringe or device supplied by Baxter Healthcare
Gelfoam	Absorbable gelatin sponge	Cut in strips of appropriate size and apply to area
Surgicel	Oxidized regenerated cellulose	Cut in strips of appropriate size and apply to area

- With prolonged PTT, give fresh frozen plasma.
- If fibrinogen is low, give 2 U of cryoprecipitate.¹

Primary volume expansion should be performed before replacing blood or blood components. One option when facing massive hemorrhage is to give cryoprecipitate initially.

When massive bleeding is anticipated or encountered, the Haemonetics Cell Saver (*Haemonetics Corp, Braintree, Mass*) is invaluable. This device, which requires a trained technician, removes blood from the operative field, anticoagulates it, and washes red blood cells, which are infused. It is accepted by many Jehovah's Witnesses,⁴ and has been used safely in women with cesarean-associated bleeding.⁵ Relative contraindications include malignancy and bacterial contamination from a ruptured abscess or inadvertent injury to unprepared bowel.⁶ The Cell Saver may be used after heavy bleeding from hysterectomy or in patients with ruptured membranes.

STEP 3

Try a topical hemostatic agent

If hemorrhage continues after arterial bleeders are secured, consider a topical

hemostatic agent (**TABLE 2**). All such agents require pressure to be applied for 3 to 5 minutes.

My preferences are Surgicel (*Johnson & Johnson, New Brunswick, NJ*) and Gelfoam (*Pharmacia, Kalamazoo, Mich*). In general, Avitene Ultrafoam collagen hemostat (*Davol, subsidiary of C.R. Bard, Murray Hill, NJ*) works poorly in the presence of thrombocytopenia and should be used with caution near the ureter.

Fibrin glue has been widely used as a hemostatic agent in microvascular, cardiovascular, and thoracic surgery.

To prepare fibrin glue at my institution, we use a double-barrel syringe to apply equal amounts of cryoprecipitate and thrombin at the same time. One fibrin sealant, Tisseal VH (*Baxter Healthcare, Deerfield, Ill*), comes with a Duploject applicator. After the agent is thoroughly applied (it is sprayed), pressure is applied for 3 to 5 minutes.

The same manufacturer also produces Coseal, which is used in vascular reconstruction to achieve additional hemostasis by mechanically sealing off areas of leakage, and Floseal, to help achieve hemostasis when ligatures or clips are impractical.

STEP 4

Hypogastric artery ligation

SALLY'S CASE
Bleeding persists

Because of the hemorrhage, a gynecologic oncology consult is obtained and the hypogastric artery is ligated bilaterally, but bleeding continues. During further exploration, the left ureter is found to be ligated. Sally receives 65 U of packed red blood cells, platelets, and fresh frozen plasma. The Cell Saver also is used.

If pelvic oozing persists after application of a topical hemostatic agent, consider hypogastric artery ligation, which controls pelvic hemorrhage in as many as 50% of patients (**PAGE 59**).^{7,8}

FAST TRACK

Perform primary volume expansion before replacing blood or blood components

Ligating the hypogastric artery

- If pelvic oozing persists after application of a topical hemostatic agent, consider hypogastric artery ligation, which controls pelvic hemorrhage in as many as 50% of patients.^{7,8}
- The major effect of hypogastric artery ligation is a decrease in pulse pressure.⁹

First, identify the **common iliac bifurcation** and retract the **ureter** medially to prevent inadvertent injury.

Next, place a right-angle clamp, lateral to medial and distal to the posterior division, so that it “hugs” the **hypogastric artery**.

Then, feed 2 large-caliber sutures into the clamp and tie them. I prefer to tie these sutures around the artery tight enough to interrupt blood flow.

Place the sutures just proximal to the origination of the **uterine artery**. If necessary, ask for assistance from a vascular surgeon or gynecologic oncologist.

If the **hypogastric vein** is the source of bleeding, retract the ureter out of harm’s way, identify and protect the obturator nerve, and use a running 2-0 MFPP suture.

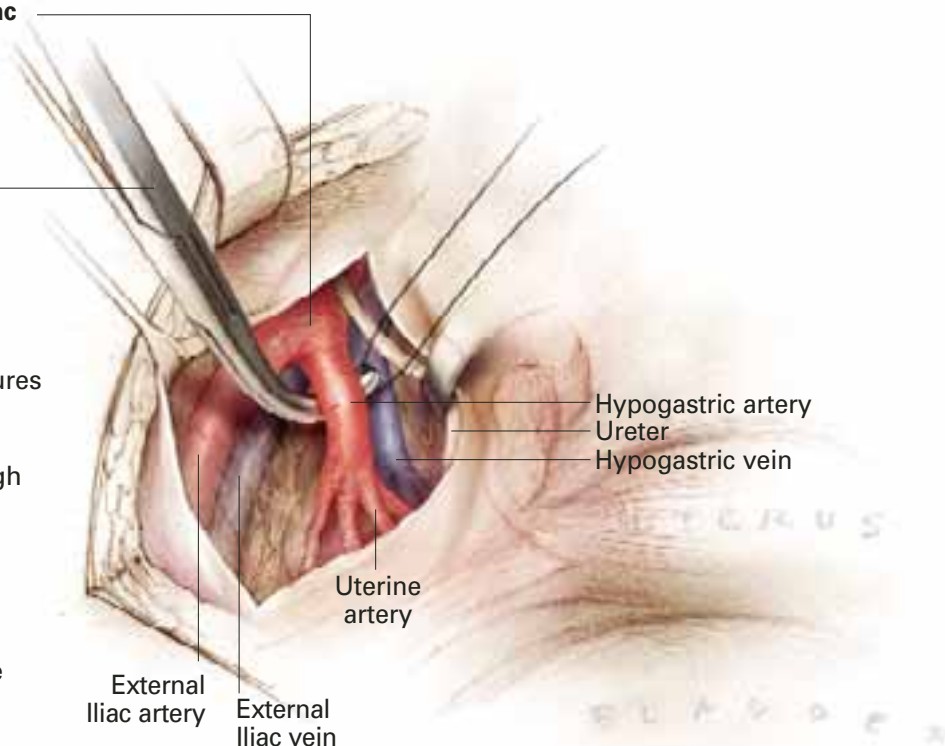


IMAGE: CHRISTY KRAMES

STEP 5

■ When all else fails: “pack and go”

If intraoperative bleeding persists despite hypogastric artery ligation and the other measures, the life-saving modality of choice is a pelvic pack left in place 2 to 3 days. I prefer a fast, simple method: “pack and go” or damage-control technique.¹⁰⁻¹²

A 2- to 4-inch Kerlix gauze (*Kendall Health Care Products, Mansfield, Mass*) is tightly packed over a fibrin glue bed from side to side in the pelvis. Only the skin is closed using towel clips or a running suture. The patient is immediately transferred to intensive care, where acidosis, coagulopathy, and hypothermia are corrected. In 48 to 72 hours, the packs are

Special cases, special tools

■ Presacral venous bleeding

Two helpful methods to quell presacral venous bleeding are:

- inserting stainless steel thumbtacks
- indirect coagulation through a muscle fragment

The thumbtack method

The presacral veins are sometimes injured during presacral neurectomy, sacrocolpopexy, or posterior exenteration. This bleeding can be controlled by inserting stainless steel thumbtacks, with direct pressure from the surgeon's hand, directly into the sacrum.¹⁵⁻¹⁷ These work by compressing veins adjacent to the bone, and are left in place permanently. No complications have been reported.

Indirect coagulation

Another method of controlling presacral venous bleeding is indirect coagulation through a muscle fragment. This is done by harvesting a 2 x 1 cm piece of muscle from the rectus abdominus and pressing it against the bleeding veins. Then set a Bovie (*Valley Lab, Boulder, Colo*) at 40 W of pure cutting current and apply it to the muscle fragment for 1 to 2 minutes. This method has been successful in 12 of 12 reported cases.^{18,19}

Other methods of controlling presacral venous bleeding include bipolar cautery, use of bone wax, and suturing in "sandwiches" of Avitene alternated with Gelfoam, but these strategies have met with limited success.

■ Pelvic hemorrhage

Arterial embolization

Angiographic insertion of Gelfoam pledgets or Silastic coils may effectively control pelvic hemorrhage in up to 90% of postpartum and postoperative patients.^{20,21} Hypogastric artery embolization can also be done intraoperatively.²²

However, this technique should be used with caution, as it may require 1 to 2 hours to perform and is inappropriate for patients with hypovolemic shock. Complications are rare, but can occur in up to 6% to 7% of patients.²¹ They include postoperative fever, pelvic abscess formation, reflux of embolic material, nontarget embolization, foot and buttocks ischemia, bladder and rectal wall necrosis, and late rebleeding.

Arterial embolization does not appear to affect subsequent pregnancies.²³

Military antishock trousers

The MAST or aviation "G" suit is sometimes used as an intermediate step to laparotomy in patients with ectopic pregnancy or postoperative or postpartum hemorrhage.²⁴ Its major use is to stabilize patients for surgery by compressing peripheral circulation, thereby diverting blood to the core circulation.

Inflate the legs first, then the abdomen; leave the MAST suit in place for 2 to 48 hours; and deflate in reverse order.

Contraindications include pulmonary edema, cardiogenic shock, rupture of the diaphragm, and pregnancy.

FAST TRACK

Presacral venous bleeding can be controlled by inserting stainless steel thumbtacks, with direct pressure from the surgeon's hand, directly into the sacrum

gently removed with saline drip assistance. If hemostasis still has not been achieved, repacking is an option.

For the Logothetopolous or "parachute" pack,^{13,14} about 6 yards of 4-inch gauze is packed in the center of a 24-inch square laparotomy tape or a sterile bowel

isolation bag, tied, and pulled through the vagina. Pressure is maintained with a weight tied to the end that is brought out through the vagina. One problem with the parachute pack is that further bleeding or injury to the bowel upon removal may not be recognized early.

SALLY'S CASE**Hemorrhage abates**

A "pack and go" technique is used to control bleeding. The fascia is left open, and the skin is closed with towel clips over the tight pelvic pack. Sally is sent to the ICU, where clotting parameters are corrected.

She undergoes reoperation 36 hours later, at which time no bleeding is encountered.

The left ureter is reimplemented into the bladder, and she makes a full recovery. ■

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