Control of Bleeding

TECHNIQUES FOR ACHIEVING HEMOSTASIS

Hemostat and Ligature

A hemostat of the proper length and design is a suitable instrument for occluding most bleeding vessels, followed by a ligature of a size compatible with the diameter of the vessel. As demanded by the situation, hemostats the size of a Halsted, Crile, Adson, Kelly, or Mixter may be indicated (see Glossary).

Polyglycolic (PG) ties are useful for most routine ligatures. Silk provides greater security when tying major vessels, such as the left gastric or inferior mesenteric artery. When the mesentery of the sigmoid colon is being divided during treatment of perforated diverticulitis, use 2-0 PG to ligate the vessels. If the splenic artery is being divided and ligated during resection of a pseudocyst of the pancreas, use a 2-0 ligature of Prolene.

Ligature-Passer

When ligating large vessels such as the inferior mesenteric, ileocolic, or left gastric artery, it is convenient to pass a blunt-tipped right-angle Mixter clamp behind the vessel. The blunt tip of the clamp separates the adventitia of the artery from the surrounding tissue. Preferably, at least 1.5 cm of vessel is dissected free. When this has been done, use a ligature-passer, which consists of a long hemostat holding the 2-0 silk ligature, to feed the thread into the jaws of the open Mixter clamp. Then draw the ligature behind the vessel and tie it. Pass the Mixter clamp behind the vessel again, feed a second ligature into its jaws, and ligate the distal portion of the vessel. Divide the vessel, leaving a 1 cm stump distal to the proximal tie and about 0.5 cm on the specimen side. Leaving a long stump of vessel distal to a single tie of 2-0 silk prevents the ligature from slipping off, even when it is subjected to the continuous pounding of arterial pulse waves.

Suture-Ligature

Two simple ligatures of 2-0 silk placed about 3 mm apart, with a free 1 cm stump distal to the ligatures, ensure hemostasis when ligating the large arteries encountered during gastrointestinal surgery. If there is not a sufficient length of artery to meet these conditions, a 2-0 silk ligature supplemented by insertion of a transfixion suture-ligature that pierces the center of the artery 3 mm distal to the simple ligature is almost as good as a free 1 cm arterial stump. Pass the suture part of the way through the vessel wall rather than completely transfixing it. This maneuver avoids bleeding through the needle hole.

Another type of suture-ligature is used in tissue into which a vessel has retracted. This problem may occur on the surface of the pancreas, where attempts to grasp a retracted vessel with hemostats can be much more traumatic than a small figure-of-eight suture of atraumatic 4-0 silk. The same figure-of-eight suture-ligature technique is valuable when a vessel has retracted into a mesentery thickened by obesity or Crohn's disease.

Hemostatic Clips

Metallic hemostatic clips offer a secure, expedient method for obtaining hemostasis, provided the technique is properly applied. These clips are useful only when the entire circumference of a vessel is visible, preferably before the vessel has been lacerated. Applying a clip inaccurately often results in incomplete occlusion of the vessel and continued bleeding, following which the presence of the metal clip obstructs any hemostat or suture-ligature in the same area. Attempts to remove the clip from a thin-walled vein may increase the rate of bleeding.

When clips are applied in an area where subsequent steps in the operation require blunt dissection or vigorous retraction, such as when performing a Kocher maneuver, the subsequent surgical maneuvers often dislodge the clips and lacerate the vessels, producing annoying hemorrhage. Hemostatic clips may similarly interfere with application of a stapling device.

It is futile to apply multiple clips in the general area from which blood is oozing in the hope it will somehow catch the bleeder. Again it must be emphasized that applying a clip is counterproductive unless a bleeding vessel can be clearly visualized.
In the absence of these contraindications, hemostatic clips speed dissection and allow secure control of bleeding vessels. An example is in the mediastinum during esophageal dissection or in the retroperitoneal area during colon resection.

**Electrocautery**

With electrocautery a locally high current density is passed through the target tissues to achieve rapid tissue heating. Monopolar cautery devices allow the surgeon to cut or cauterize with a blade-like tip. The return current path is through a large grounding electrode placed on the patient’s thigh or back. Two types of current are supplied by most electrocautery generators: cutting and coagulating. Cutting current is continuous-wave, high-frequency, relatively low-voltage current. It produces rapid tissue heating, which allows the blade of the cautery to cut through tissue like a scalpel. There is minimal hemostatic effect. Coagulating current is pulsed-waveform, low-frequency, high-voltage current that heats tissues slowly. The resulting protein coagulation seals small vessels.

Cautery is most effectively employed by grasping the bleeding vessel with forceps or a hemostat, elevating it slightly above surrounding tissue, and then touching the cautery blade to the instrument. The resulting coaptive coagulation seals the front and back wall of the collapsed vessel together. Small punctate bleeders may be secured by touching them directly with the tip of the cautery.

Bipolar cautery units generally have a forceps-like configuration that facilitates use of coaptive coagulation. It is less useful, however, for cutting.

Electrocautery is a valuable, rapid means to achieve hemostasis, provided certain contraindications are observed. Vessels that have an external diameter of more than 2-3 mm should not be electrocauterized. As with hemostatic clips, any tissue that will subsequently be subjected to blunt dissection or retraction may not be suitable for electrocautery, as the friction often wipes away the coagulum, causing bleeding to resume. Fat does not conduct electricity well, and extensive use of cautery in fatty tissues may result in excessive tissue destruction. Similarly, when many subcutaneous bleeding points are subjected to electrocaugetration, the extensive tissue insult may contribute to wound infection.

**Ultrasonic Shears**

Ultrasonic shears were initially introduced for minimal access surgery but are now available with shorter shanks for use during open surgery. These devices use ultrasound to heat and coagulate tissue in a coapted position. The tissue is then cut with the device or with scissors. Slightly larger vessels (e.g., short gastric vessels or vessels in the lateral rectal pedicles) may be secured with this device rather than with coaptive coagulation using electrocautery.

**Physicochemical Methods**

**Gauze Pack**

Physical application of a large, moist gauze pad has been employed for decades to control diffuse venous oozing. It enhances the clotting mechanism because pressure slows down the loss of blood, and the interstices of the gauze help form a framework for the deposition of fibrin. Unfortunately, after the gauze pack is removed bleeding sometimes resumes. Packing has been lifesaving after major hepatic trauma or for persistent pelvic bleeding during abdominoperineal resection, particularly when the patient has become cold or developed a coagulopathy. Packs may be left in and removed after 24 hours when the patient is stable and all hemostatic parameters have returned to normal.

**Topical Hemostatic Agents**

A variety of topical hemostatic agents are available in powder, sheet, and woven form. They vary in chemical formulation, but most are collagen or cellulose derivatives and act as a matrix and stimulant for clot formation; thus the patient must be able to form clot for these agents to work. It is wise to remember the old axiom that topical agents work best in a dry field. In other words, these agents are adjuncts that help stop oozing but do not substitute for definitive hemostasis of individual bleeding vessels.

Topical agents may be applied in a thin layer to an oozing surface, such as liver or spleen from which the capsule has been avulsed. An overlying gauze pad is then placed and pressure applied. When the pack is removed 10-15 minutes later, the topical hemostatic agent remains adherent to the surface, preventing disruption of the coagulum that is forming underneath. Choice of an agent is dictated in part by the physical geometry of the bleeding site (powders are best for irregular surfaces), availability, and surgeon preference.

Avitene (microfibrillar collagen) comes in powdered form to be sprinkled on a bleeding surface, or it can be applied with clean, dry forceps. Any moisture on instruments or gloves that come into contact with Avitene causes the Avitene to stick to the moist instrument rather than to the bleeding surface. If blood oozes through the layer of Avitene, another layer should be applied and pressure exerted over it. When flat surfaces of a denuded spleen or gallbladder bed are oozing, oxidized cellulose seems to be as effective as Avitene at one-twentieth the cost.

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