Laparoscopic Surgery of the Spleen

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25.1 Introduction

Splenectomy may be indicated in the treatment of a number of diseases including benign and malignant hematological conditions, cysts, trauma or splenic aneurysms. An organ situated deep in the left hypochondrium and difficult to access, the spleen remains poorly understood with regard to its physiology and function. Delaitre (Paris), Carroll (Los Angeles) and Poulin (Montreal) were the first to report successful laparoscopic splenectomy in humans [1–6].

The spleen is a fragile and highly vascularized organ, receiving as much as 20 % of the cardiac output. Many hematological diseases for which splenectomy may be indicated are associated with a reduced platelet count, which increases the risk of bleeding and spleen enlargement. As well as being deeply recessed, the spleen is directly attached to several organs. These factors all contribute to the level of difficulty in the performance of laparoscopic splenectomy and advanced training on the part of the surgeon is required.

25.2 Indications and Contraindications

Laparoscopic splenectomy has been applied across the spectrum of splenic diseases. Its best indication is the treatment of benign hematologic conditions with a normal or slightly enlarged spleen, as is seen in ITP (idiopathic thrombocytopenic purpura), AIDS-related ITP, hemolytic anemia, or spherocytosis. Laparoscopic splenectomy for malignancy is more controversial because it may require additional resection of lymph nodes or even the removal of an intact specimen.

Although splenomegaly is a relative contraindication for laparoscopic splenectomy, it is feasible in cases of moderate splenomegaly, with a spleen weighing up to 1500 g or a maximal dimension of 25 cm. Massive splenomegaly is not an absolute contraindication. Experience with devices for 'hand-assisted' laparoscopic splenectomy indicates that massive splenomegaly could be a good indication for this technical alternative. Portal hypertension, on the other hand, does not appear to be a good indication, but experience is as yet scarce.

25.3 Set-Up and Patient Positioning

Patients undergoing elective laparoscopic splenectomy do not require any special preparation. A preoperative CT or ultrasonography is recommended to evaluate the size of the spleen or to rule out the existence of accessory spleens (AS) whose intraoperative identification may be difficult.

Many indications for laparoscopic splenectomy are related to low platelet counts where the risk for intraoperative hemorrhage is increased. Several preoperative measures have been proposed to increase the number of platelets and/or diminish the risk of hemorrhage. These include an intravenous bolus of corticosteroids or incremental doses of immune gamma globulins, mainly in patients with autoimmune thrombocytopenic purpura. Poulin et al. proposed preoperative splenic artery embolization to occlude terminal vascular branches and diminish the risk of bleeding as well as to reduce spleen size. Patients who underwent splenic artery embolization showed significantly less intraoperative blood loss and consequently a lower rate of emergency blood transfusion (up to 10 % less). Splenic artery embolization is an invasive procedure and is associated with pain, hemorrhage and hepatic or splenic abscesses. Although preoperative splenic artery embolization is not recommended routinely for laparoscopic splenectomy, it may play a role in massive spleens measuring more than 25 cm in their maximum dimension. An additional intraoperative method to achieve normal platelet count could be fresh platelet transfusion. This method is, however, usually restricted to patients with ITP related to HIV infection, due to the theoretically increased risk of other viral infections through pooled platelet transfusion.

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Polyvalent pneumococcal, meningococcal and H. influenzae vaccines are administered prior to surgery. Antibiotic prophylaxis is initiated immediately preoperatively. Laparoscopic splenectomy is performed under general endotracheal anaesthesia. Decompression of the stomach with an oral gastric tube is recommended. It is removed upon completion of the surgery.

Preoperative anti-aggregant therapy is warranted, especially in patients with additional risk factors such as myelofibrosis.

25.4 Instrument Checklist

Laparoscopic splenectomy can be performed in any operating room suitable for conventional laparoscopy and does not require any special equipment. When available, mobile booms and shelves can serve to support video monitors and other laparoscopic equipment, reducing operating room clutter. The use of *two video monitors* improves the surgeon's comfort and efficiency. Laparoscopic splenectomy is usually performed using *three or four trocars*. The laparoscope is often moved between the trocars to enhance visualization. If a 10 mm scope is used, at least two of the ports must be **10–12** mm in size whereas if a 5 mm (or smaller) scope is used, only one port needs to be **10–12** mm. An *angled (30° or 45°)* laparoscope is most commonly used for LS, although some surgeons prefer to use the 0° optic. Most grasping, dissecting and cutting instruments used in this procedure are 5 mm in diameter. It should also be mentioned that mini laparoscopic (2–3 mm) instrumentation is being used more widely, especially for pediatric patients.

Different methods for hemostasis should be readily available in the operating room such as: endoloops, clip appliers, endovascular stapling devices, electrocautery (mono or bipolar), and computed controlled bipolar cautery (Ligasure™). The ultrasonic dissector (Ultracision™) is also a very useful tool for spleen dissection. Clips should be used with care to avoid their placement in sites where an endostapler may also be applied as they can block the functioning of the stapler. Endovascular staplers are very useful, mainly for control of splenic hilar structures. A durable nylon sack should be considered key equipment for laparoscopic splenectomy. Such a sack must be able to withstand the rigors of the final morcellation process once the spleen is in the bag and prior to specimen extraction.

25.5 Surgical Anatomy

The important anatomical aspects of the spleen are its vascularization and its great number of relationships with adjacent organs. The spleen has in essence a double blood supply: short gastric vessels and a main hilar vascular trunk. Although highly variable, splenic anatomy has been classified into two main patterns: the distributed and the magistral types. The more common distributed type (70 %) consists of a short splenic trunk with numerous long branches entering the splenic hilum. In the magistral type, a long main splenic artery divides into short terminal branches in the hilum. There are also accessory polar vessels and anastomoses with gastroepiploic vessels. These anatomic details require that the surgeon be completely familiar with the variable and anomalous extrasplenic vascular anatomy.

The spleen is fixed by several ligaments and peritoneal folds to the colon (splenocolic ligament), the stomach (gastrosplenic ligament), the diaphragm (phrenosplenic ligament), the kidney, adrenal gland and tail of pancreas (lienorenal ligament). These attachments are avascular and can be safely sectioned under the direct vision and magnified image of the laparoscope with the help of the ultrasonic dissector.

Despite the fragility of the splenic parenchyma, its capsule is solid and can be manipulated without rupture if handled with care. Prior to extraction of the spleen, the morcellation process (within a durable bag) is facilitated by the frail structure of the spleen.

25.6 Lateral Approach

The patient is placed in the right lateral decubitus position with the flank at the level of the articulating point of the operating table. The table is broken 20–30° below level in both cephalad and caudad portions and the patient is placed in moderate reverse Trendelenburg position (Fig. 25.1). This serves to maximize the window of access between the patient's left iliac crest and costal margin.

Three trocars are then inserted in the patient's left upper quadrant. An 11 mm port is inserted in the anterior axillary line superior to the patient's anterior superior iliac spine. This trocar is used for the endovascular stapler and ultimately for the removal of the spleen. The trocar that is most frequently used for the camera is placed in the rim of the umbilicus in pediatric and slender patients. For larger patients it is often necessary to move this site into the left upper quadrant. A left subcostal or subxiphoid trocar is also inserted for a retracting or grasping instrument. Finally, a dorsal trocar (2 or 5 mm) is placed under direct vision below the twelfth rib in the mid to post axillary line. A retracting forceps to elevate the lower pole of the spleen is passed through this trocar (Fig. 25.2).

Dissection begins with mobilization of the splenic flexure of the colon (Fig. 25.3). This is done with a combination of sharp dissection and the ultrasonic dissector. The lateral peritoneal attachments of the spleen are then incised. A cuff of peritoneum is left along the spleen. The retracting forceps can be used either to grasp the peritoneal cuff and mobilize the spleen medially or placed under the inferior pole to elevate it. In this way the spleen is never grasped directly.

Dissection of the splenic hilum is begun from the lower pole and continued in a cephalad progression. A lower pole splenic vessel is often present and should be divided between clips or with the ultrasonic dissector.

Once the lower pole of the spleen has been mobilized and the polar vessels have been divided, entry into the lesser sac is facilitated. With the spleen elevated, the short gastric vessels and main vascular pedicle are tented. The short gastric vessels can be divided with the ultrasonic dissector, clips or the endovascular stapler. The tail of the pancreas is often visible at this point of the dissection. The splenic pedicle is well exposed and can easily be accessed. The main artery and vein, once dissected free, are divided by separate applications of the endovascular stapler (Fig. 25.4).

If a concomitant procedure such as cholecystectomy is to be performed, the patient will need to be rolled supine and a further (2 or 5 mm) port introduced into the patient's right upper quadrant.

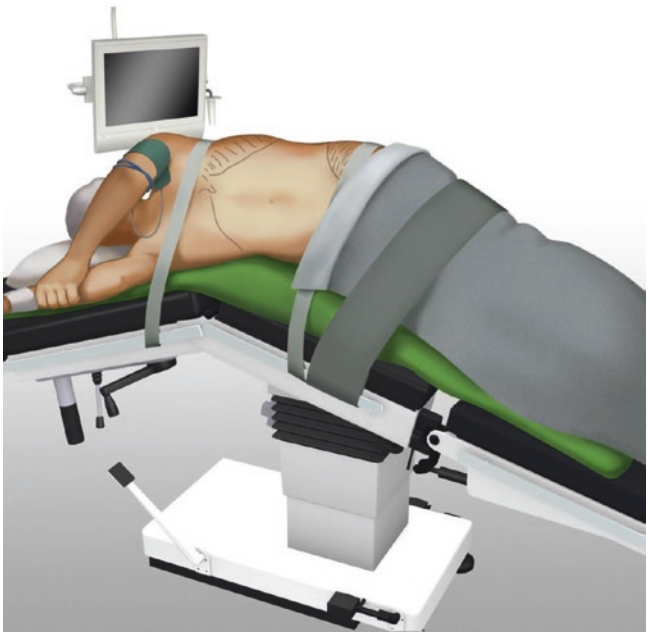

Fig. 25.1 Patient positioning for laparoscopic splenectomy in lateral position

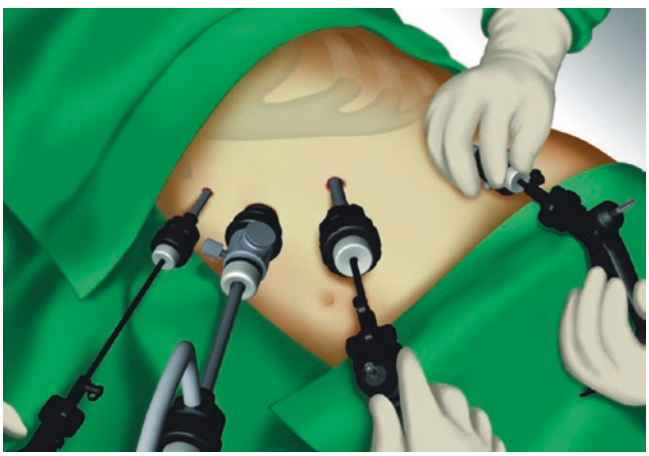

Fig. 25.2 Trocar placement for laparoscopic splenectomy

Fig. 25.3 Dissection of the splenocolic ligament

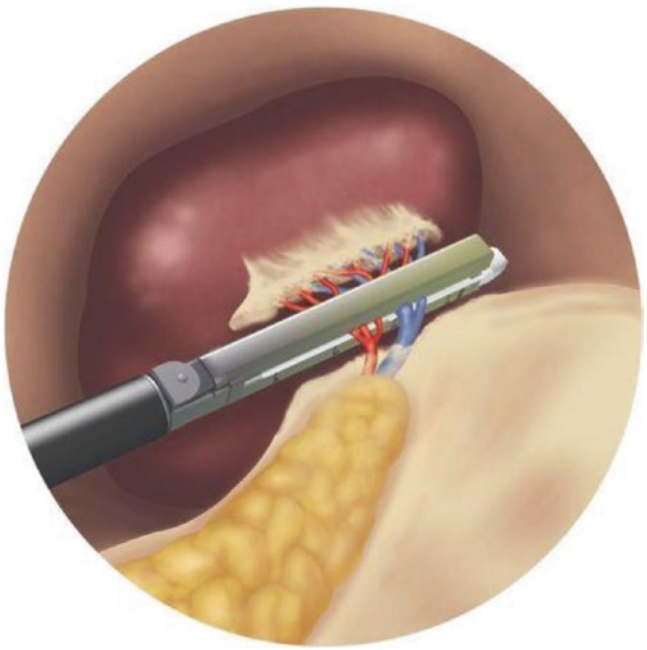

Fig. 25.4 Stapling of splenic artery and vein

25.7 Extraction of the Specimen

Once the remaining splenic hilar and short gastric vessels have been divided, a small cuff of avascular splenophrenic ligament is temporarily left in situ. This serves to hold the spleen in its normal anatomic position and will greatly facilitate placing it into a sack for extraction. The sack is introduced and unfurled. It is then maneuvered over the relatively immobile spleen. The final spleno-phrenic attachments are then divided and the drawstring on the sack is closed. The neck of the sack is withdrawn through the 11 mm trocar. Within the sack the spleen is morcellated with blunt clamps or by finger fracure and extracted piecemeal. As intra-abdominal contamination from splenic material and subsequent splenosis are to be avoided, great care must be taken to insure that the bag is not ruptured. Furthermore, a change of gloves after extracting the spleen is recommended. Once the entire specimen and sack have been removed, a final laparoscopic survey and irrigation are performed.

The introduction of the spleen into the bag may prove difficult if the spleen is enlarged and can be made easier if the bag's opening is of a large diameter with an aperture device controlled from the exterior.

On some occasions, such as in the case of rare primary or secondary splenic tumours, the spleen should be retrieved intact, though pathologists usually have sufficient diagnostic material with the morcellated specimen. In the event that it is necessary to extract the spleen intact, an accessory incision must be used. This incision can be made in various locations on the abdomen or through the widening of a trocar incision, or a Pfannestiel or umbilical incision can be made. A posterior culpotomy has also been suggested for extraction of the specimen.

25.8 Hand-Assisted Laparoscopic Splenectomy

In the hand-assisted laparoscopy splenectomy procedure, the patient is placed in right lateral decubitus position. With massive splenomegaly, the lateral position is reduced to 30–45° to prevent the spleen from falling. A pneumoperitoneum is created with a Veres needle inserted into the right iliac fossa at a good distance from the spleen. A 12 mm trocar is inserted in the periumbilical area to perform an exploratory laparoscopy and to select the best site for an accessory incision (7–7.5 cm) to insert the hand. It is usually made in the right hypogastrium, but in cases of massive splenomegaly it is made in the right subcostal area or in the right iliac fossa (Fig. 25.5). Once the incision is made, the device (Lapdisc, Ethicon, Somerville, NJ, USA; Omniport, Advanced Surgical Concepts Ltd, Dublin, Ireland; Handport, Smith Nephew, Andover, MA, USA) is introduced. Usually, the non-dominant left hand is then inserted into the abdomen to examine the shape of the spleen and surrounding anatomy. A second 12 mm trocar is inserted laterally to the laparoscope under manual control. All the instruments are introduced using this trocar. When additional retraction is needed, a 5 mm trocar is placed in the left flank and an endoretractor (Endoflex, Genzyme, Tucker, GA, USA) is inserted to expose the anterior face of the spleen. The first step in the procedure is to access the retrogastric pouch through the gastrosplenic omentum.

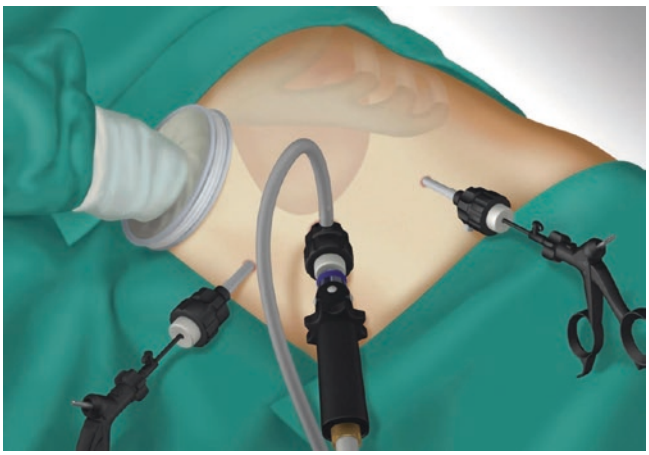

Fig. 25.5 Placement of hand port and trocars for hand port assisted laparoscopic splenectomy

The whole of the great curvature of the stomach is freed until the short vessels are sectioned with the ultrasonic shears (Ultracision™, Ethicon, US) or bipolar device (Ligasure™, Valleylab, US). The splenic artery is located by palpation in the upper border of the pancreas and a ligature or clip is placed to interrupt the inflow of blood into the spleen. The hand then mobilizes the spleen medially to expose its posterior surface and the retroperitoneal adhesions are dissected. The splenic hilum and pancreatic tail are bluntly dissected with the hand. Using this dissection, the endostapler can be placed in the splenic hilum in such a way that it can be fired without tension, sparing the pancreatic tail. Once the hilum is controlled, the upper pole is dissected from the posterior attachments and the spleen is freed. In most cases, the spleen is retrieved intact through the accessory incision. However, in cases of massive splenomegaly, a sterile plastic bag (Endocatch II, Tyco, Norwalk, CN USA) or a bag used for liver harvesting during liver transplantation is introduced into the abdomen and the spleen is placed inside it and then morcellated. It is then removed in large pieces through the 7 cm incision. Although most authors prefer the surgeon's non-dominant hand for intra-abdominal insertion, some favor the assistant's.

Partial splenectomy may be indicated in selected cases. Anatomical requirements for partial splenectomy include a

distributed vascular irrigation of the spleen, with segmental branches originating out of the spleen. The segmental anatomy of the spleen facilitates partial splenectomy, because a clear transection line is easily observed after the ligature of the branches that irrigate the area to be excised. Partial splenecomy is particularly indicated in children and with localized splenic diseases such as masses or cysts located in either pole of the spleen.

25.9 Specific Complications of the Technique(s), How to Avoid Them, and Management of Complications

Independently of any complications inherent to laparoscopic surgery in general (e.g. related to pneumoperitoneum, injuries from trocars), laparoscopic splenectomy is associated with several potential perioperative complications that the surgeon should be aware of and be able to treat. The greatest potential problem is hemorrhage, which can be of three types: from a small calibre vessel (short gastric or polar vessels), a larger vessel of the hilum, or the splenic parenchyma. The first type of hemorrhage, though not life threatening, can become quite a hindrance to the operation as rapidly accumulating blood may impede vision, but it can also be easily stopped with clips, electrocoagulation or the ultrasonic dissector. Hemorrhage from a larger vessel may be an indication for immediate conversion to laparotomy. It is best prevented by delicate dissection of the artery and vein to prevent rupture of smaller splenic and pancreatic blood vessels. The dissected artery and vein should then be clipped prior to any movement of the spleen. The rigidity of the clamping instruments alone can suffice to injure these vessels. Hemorrhage originating in the parenchyma is less dangerous and can be managed either by clamping the artery or applying slight pressure with gauze, or electrocoagulation.

Another potential complication of laparoscopic splenectomy is injury to the tail of the pancreas. Proper dissection and placement of the endostapler can avoid this problem. The use of the lateral approach to laparoscopic splenectomy allows the splenic hilum to lengthen and this permits the endostapler to be used without risk of damaging the pancreatic tail. A further possible complication of laparoscopic splenectomy is perforation of the diaphragm during dissection of the superior pole of the spleen. A small puncture may be quickly amplified by the presence of pneumoperitoneum, causing a pneumothorax. This can be controlled laparoscopically and with a pleural drain.

Other complications reported with laparoscopic splenectomy include deep vein thrombosis, portal vein thrombosis, pulmonary embolus and wound infection. Recent reports have suggested a higher incidence of portal thrombosis with laparoscopic splenectomy. No clear relation to pneumoperitoneum has been found, but close monitoring of postoperative thrombocytosis and preoperative antiaggregant therapy is warranted, especially in patients with additional risk factors such as myelofibrosis. It is interesting to note that particularly in the largest series of laparoscopic splenectomy, there is a remarkably low incidence of deep surgical infection or subphrenic abcess.

25.10 Limitations, Caveats and Controversies Related to the Technique(s)

While performing LS the surgeon must always be mindful of the possibility of the existence of accessory spleens, particularly in the treatment of ITP or spherocytosis. Accessory spleens are present in 10–30 % of patients and can be found in the splenic fossa next to the colon or the stomach as well as in the omentum or below the mesocolon. They should be excised at the beginning of the procedure, otherwise they may be mistaken for hematomas as the operation progresses. Laparoscopic ultrasonography or a radioisotope detection probe for intraoperative identification of accessory spleens has been suggested but their efficiency has not been established. Accessory spleens may cause therapeutic failures of splenectomy and can require repeat intervention. Some cases of laparoscopic treatment of accessory spleen left in situ have been published.

Moderate splenomegaly (spleens of less than 20 cm in length or approximately 1000 g) does not constitute a clear contraindication to LS yet may be associated with greater technical difficulty in performing the procedure. This is especially true during the steps of mobilization of the spleen and its introduction into the sack. It should be noted that dissection of the splenic hilum is not rendered more difficult in cases of splenomegaly because the vascular structures remain in their normal anatomic position and may even become somewhat elongated and therefore easier to ligate and divide. The advantages of laparoscopic splenectomy for massive splenomegaly are not yet well established. Liberation of the posterolateral ligaments of the superior pole of an enlarged spleen can be particularly difficult. When the spleen is elevated with endoseparators, access to the posterior aspect of the superior pole is blocked. When the organ size is such that it crosses the midline and reaches all the way to the iliac crest, it is extremely difficult to introduce the spleen into a sack intracorporeally and it is preferable to extract the specimen through an accessory incision. It has been proposed that the spleen be fragmented into five or six pieces within the abdomen and then be extracted through a Pfannestiel incision, but this method is not generally endorsed due to the risk of subsequent splenosis.

25.11 Laparoscopic Treatment for Other Splenic Disorders

An interesting indication for laparoscopic surgery of the spleen is in the treatment of primary *cysts* or (secondary) cysts following splenic trauma. The most accepted treatment approach is the observation of lesions of less than 5 cm, but larger cysts require excision due to the risk of rupture, hemorrhage, or infection. Splenectomy has been considered the treatment of choice for benign cystic lesions of the spleen. Other less invasive alternatives such as percutaneous aspiration often lead to recurrence of the cysts. In the last few years, organ conserving techniques have been developed and reported with good results, including partial splenectomy and partial excision of the cysts. In 1985, Salky et al. performed the first laparoscopic treatment of a splenic cyst, aiding in the wider application of laparoscopic surgery. Extirpation of the cyst is safe, effective and less aggressive than splenectomy. If the cyst is located in a difficult area for a conservative approach (hilum or superior pole), total splenectomy is recommended.

The laparoscopic approach has also been suggested for the treatment of splenic aneurysms. Hashizume et al. successfully treated an aneurysm of the splenic artery, ligating both ends of the aneurysm while preserving the spleen.

The use of laparoscopy for the diagnosis of intra-abdominal injuries has been recommended for years but was not widely used until laparoscopic cholecystectomy became common and videolaparoscopy caught the interest of abdominal surgeons. Many studies throughout the 1970s and 1980s proved the usefulness of laparoscopy in the detection of intra-abdominal injuries. Two prospective randomized studies comparing exploratory laparoscopy with peritoneal lavage have demonstrated similar sensitivities (100%), although laparoscopy showed superior specificity. These studies suggest that laparoscopy may serve a role in the exploration of cases where peritoneal lavage has not produced a definitive diagnosis.

Therapeutic laparoscopy has also been described for splenic injuries. The techniques most commonly used are aspiration of clots, application of a hemostatic agent for capsular splenic tears, and placement of an absorbable mesh in the case of a highly mobile spleen.

Specific "Tips and Tricks"

1. Carefully evaluate the anatomy of the spleen (CT scan) and the patient's biological status (coagulation parameters).
2. Select the table position (full lateral, semilateral or supine) depending on the volume and shape of the spleen.
3. Consider using the Hasson technique and avoid tearing the spleen when inserting a trocar.
4. After laparoscopic examination, consider conversion to HALS if the size of the spleen hampers its mobilization.
5. If HALS is used, consider making the port incision below the sternum or costal margin as it permits conversion through a subcostal incision.
6. Control the artery first. It is easily located and simple clipping or ligature permits a reduction in spleen volume.
7. A large upper or lower pole located near the midline implies increased technical difficulty.
8. Locate the tail of the pancreas. Enlarged nodes may hamper localization.
9. Assure hemostasis, as it may be more difficult than after open surgery.
10. Drainage is advised in the presence of clotting anomalies or oozing surgical field.

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