Prevention and Management of Complications of Laparoscopic Splenectomy

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Abstract Laparoscopic splenectomy (LS) has become a commonly performed minimal-access operation. With increasing experience, surgeons are undertaking LS for multiple pathologies and tackling spleens of diverse sizes. LS remains a challenging procedure to be performed by experienced laparoscopic surgeons, well supported by a team. Bleeding remains the commonest intraoperative complication and perhaps the commonest reason for conversion to a laparotomy. Although the incidence of postoperative complications following LS is lower than that after open splenectomy, thrombosis of the splenoportal axis is being increasingly recognised. The present review describes both the common as well as uncommon intraoperative and postoperative complications of LS and outlines measures to be taken for their prevention and management.

Keywords Laparoscopy · Splenectomy · Complication · Haemorrhage · Abscess · Portal vein thrombosis

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Introduction

Open splenectomy (OS) is usually not a technically demanding procedure, except when undertaken for the removal of a massively enlarged spleen [1]. However, it requires a laparotomy via a long midline or a subcostal incision. The spleen's abundant blood supply, its anatomic proximity to vital intra-abdominal organs along with the traction and manoeuvres necessary for its exposure result in an overall complication rate of 5–60% [2–5]. The complications of OS are mainly secondary to bleeding or injury to the pancreatic tail or are pulmonary in origin. OS for malignant diseases or enlarged spleen may be associated with morbidity to the tune of 40–60% [3–5]. In recent years, LS has become increasingly popular and is being performed for treating patients with a variety of disorders. LS leads to a decrease in the complication rate because of the reduction in the trauma of access, a magnified view of the operative field and avoidance of the manipulation of the left side of the diaphragm. However, LS also entails technical difficulties because of the frail nature of the spleen and its complex vasculature. In addition, the specific features of haematological diseases such as splenomegaly and low platelet count pose further challenges during LS. This review describes the various complications encountered while performing LS and outlines strategies for their prevention and management.

Intraoperative Complications

Haemorrhage from the Spleen

The spleen is a pulpy organ that is easily injured during retraction, while the hilar vessels are delicate and can be torn during surgical manipulations. The haemorrhage can

Fig. 1 Tear in a large spleen (*arrow*) caused by retraction

occur from the spleen either due to a laceration of the splenic capsule or parenchyma [6] with instruments or retractors (Fig. 1) or inadequate ligature or control of the splenic vessels [7]. In patients who have received steroids over a prolonged period, the splenic capsule may become more prone to rupture.

Prevention and Management Preoperative correction of coagulation defects, excellent visualisation of important structures and careful dissection minimise the incidence of intraoperative bleeding. Delicate handling of the instruments retracting the spleen is required to avoid bleeding from the spleen. Bleeding from the splenic parenchyma is best managed by packing the area with a gauze piece and proceeding with dissection once the bleeding reduces in its severity. Rapid mobilisation and control of the pedicle is perhaps the only way to control the slow ooze that continues from the parenchyma. Rarely, the bleeding is brisk enough to preclude safe completion of LS and a conversion is required. Bleeding from a splenic hilar vessel should be controlled by clamping the area with the left-hand grasper and precisely applying clips to the bleeding vessel. Preoperative embolisation of the splenic artery to reduce the risk of haemorrhage has been reported [8, 9]. In addition to significantly increasing the cost of laparoscopic splenectomy, preoperative embolisation exposes the patient to morbidity in the angiography suite such as pancreatitis, inadvertent thrombosis of the vessels, groin puncture-site problems and contrast reactions. This technique has failed to gain popularity. The surgeon should assess the pattern of splenic vasculature (distributed or magistral) early during the course of the operation and plan the operative strategy based on the assessment. If a distributed anatomy is present, the splenic branches can be usually dissected individually and clipped. This is the least costly as well as the simplest approach, as the vessels are spread over a wider area of the splenic hilum. In contrast, if the blood supply appears

magistral, consideration should be given to controlling the entire pedicle with a single application of a linear stapler device. Before the use of the stapler, a window should be created above the hilar pedicle in the splenorenal ligament so that all structures can be included within the markings of the linear stapler under direct vision. Particularly in patients with a low platelet count (e.g., idiopathic thrombocytopenic purpura (ITP)), the splenic artery should be controlled early by opening the lesser sac (Fig. 2). This technique not only allows the platelet count to increase intraoperatively but also devascularises the spleen and reduces the chance of bleeding from the spleen. Furthermore, the splenic size reduces as the splenic vein continues to drain blood away, thus making the spleen softer, easier to handle as well as more convenient to extract. During dissection of the splenic vein, utmost care should be taken not to handle the vein directly with a grasper. Adequate space should be created behind the spleen before the splenic vein is controlled. This allows the area to be clamped with a long soft bowel grasper in case of bleeding from the splenic vein. In the eventuality of bleeding from the vein, unless prompt control can be achieved, the safest course of action is expeditious conversion to a laparotomy.

Haemorrhage from other Sources

Other sources of haemorrhage during LS include the variable arterial supply to the lower pole of the spleen, the short gastric vessels, the left gastroepiploic artery, small vessels in the retroperitoneal attachments of the spleen and the vessels along the tail of the pancreas [10]. At times, dense omental adhesions in the splenic hilum are liable to bleed on application of traction during dissection and need to be controlled by rapid clamping followed by clipping of the bleeding vessel or its coagulation with an energy source. Interestingly, despite the high incidence of throm-

Fig. 2 Early ligation of the splenic artery in the lesser sac (*arrow*) in a patient with ITP

bocytopenia in patients undergoing LS, the frequency of haemorrhagic complications related to laparoscopic port sites is extremely low [11, 12].

Prevention and Management LS is a challenging operation requiring the surgeon to be facile in the dissection of complex tissue planes and well versed with the control of blood vessels. The short gastric vessels may be coagulated either with bipolar diathermy or with ultrasonic shears, taking care not to allow the energy source to come in direct contact with the adjacent stomach. Brisk bleeding that sometimes ensues as a result of inadequate or incomplete coagulation of a short gastric vessel may be managed by quickly clamping it with the left-hand grasper, suctioning the field to improve vision and precisely clipping or coagulating the vessel.

Injury to Adjacent Organs

- A) **Colon:** Injury to colon occurs rarely during LS. One of the initial steps during LS involves mobilising the splenic flexure of the colon. During this step, cautery injury or direct trauma from the ultrasonic shears is possible. The colon may also be injured with the Verres needle or trocar during the initial access.

Prevention and Management Adequate precautions during the initial access—whether performed by the open or the closed method—are essential. All the secondary trocars should be inserted under vision, whenever appropriate after taking down adhesions in the region of the splenic flexure. The most important issue concerning intraoperative colonic injury is to recognise the problem and repair it at the time of the laparoscopic procedure. Primary repair of small colonic injuries may be possible laparoscopically. However, through-and-through colonic injuries are best dealt with by conversion to an open procedure. If the injury is not noted intraoperatively, the patient may present later with peritoneal sepsis requiring emergency laparotomy and possible colostomy.

- B) **Pancreas:** Injury to the tail of the pancreas is most likely to occur if the tail of the pancreas is close to the splenic hilum and can be a result either of direct trauma to the organ or from devascularisation of the pancreatic tail. Direct trauma most often occurs from en masse stapling across the hilum of the spleen during which pancreatic tissue is included in the staple line.

Prevention and Management It should be possible at the time of surgery to identify the pancreatic tail and dissect it away from the spleen far enough to allow control of the

hilar vessels without pancreatic disruption. If the pancreatic parenchyma has been violated at the time of LS, a closed-suction drain should be placed. Unrecognised pancreatic injury may present with left upper quadrant pain, fever, pleural effusion, elevated white blood cell count and hyperamylasemia. Computed tomography (CT)-guided catheter placement is usually sufficient to drain and control the fistula until it closes. Pancreatic stenting may be required if the fistula continues to drain for a prolonged period. Rarely, surgical intervention in the form of distal pancreatectomy may be required.

- C) **Stomach:** Gastric injury may occur during placement of the trocars if it is not adequately decompressed by means of a nasogastric tube. A thermal injury is likely during the dissection and control of the short gastric vessels.

Prevention and Management During dissection close to the stomach, judicious use of energy sources is essential to avoid gastric injuries. Gastric perforation or gastric serosal injuries during LS should be treated with laparoscopic suture repair.

Haematological Complications

Failure to Remove Accessory Spleens and Persistent Thrombocytopenia

The reported incidence of accessory spleens (AS) varies widely, ranging up to 30% [13]. Failure to identify and remove all the accessory splenic tissue may lead to recurrent or persistent thrombocytopenia. The incidence of development of persistent thrombocytopenia following LS appears to compare favourably with that after OS.

Prevention and Management Preoperative imaging does not appear to be of sufficient sensitivity to justify its use on routine basis for localising accessory splenic tissue during LS. Experience is an important factor in locating AS. In most cases, they should be readily identifiable with standard laparoscopic techniques. The splenic hilum, gastrosplenic omentum, gastrocolic ligament and region along the tail of the pancreas should be inspected carefully for the presence of AS. A thorough visual exploration should be carried out at the beginning of the operation. The removal of AS laparoscopically is usually straightforward, dissecting the accessory organ with diathermy (Fig. 3) or ultrasonic shears and removing it with an impermeable bag. In patients who develop thrombocytopenia after surgery, modalities such as CT scan, magnetic resonance imaging or nuclear imaging with indium-111-labelled autologous pla-

Fig. 3 Accessory spleen being excised (arrow)

telets might localise suspicious tissue for subsequent resection. The persistent splenic tissue can be excised laparoscopically by experienced surgeons [14, 15] or through an open approach.

Splenosis

Splenosis is the result of autotransplantation of splenic tissue during surgical manipulation of the spleen. Multiple small implants of splenic tissue (splenunculi) grow in scattered areas on the peritoneal surfaces throughout the abdomen (Fig. 4). Although implants of splenosis are generally asymptomatic, they may present with abdominal pain, as a mass or as intestinal obstruction. Furthermore, there may be recurrence of the haematological disorders for which the patient underwent splenectomy.

Prevention and Management Precautions must always be taken during manipulation of the spleen to avoid capsular disruption that can lead to splenosis and recurrent haemato-

Fig. 4 Florid splenosis in a patient who had previous LS for hereditary spherocytosis

logical disease. If rupture does occur, immediate suction and a thorough search for splenic fragments must be undertaken. Strong impermeable bags should be used for extraction so as to avoid spillage.

Postoperative Complications

Postoperative Haemorrhage

Haemorrhage is usually recognised intraoperatively and treated, but can rarely occur postoperatively as well. The common sites are the splenic vessels at the tail of the pancreas, the short gastric vessels and the trocar sites. Postoperative haemorrhage is manifested by left shoulder pain, progressive abdominal distension, tachycardia and hypotension along with a falling haemoglobin level.

Prevention and Management A diligent surgical technique to ensure proper intraoperative haemostasis as well as practice of reinsertion of the laparoscope for a final

Fig. 5 **a** Massive haemoperitoneum and a bleeding splenic artery (arrow) discovered upon reinsertion of the laparoscope at the conclusion of an uneventful LS and extraction of the specimen. **b** Underrunning of the bleeding vessel (arrow) during urgent laparotomy

Fig. 6 CT scan showing a portal vein thrombus (arrow) in a patient following LS for myelofibrosis (courtesy Dr Rasik Shah, Mumbai)

inspection of the operative field after removal of the specimen should be routine (Fig. 5a and b). A patient who becomes haemodynamically unstable in the postoperative period is rapidly resuscitated and an exploration is performed via a laparotomy. In a stable patient, relaparoscopy may be carried out since the problem could be a technically simple one to correct, such as bleeding from a short gastric vessel or a trocar site. Adequate preoperative fluid resuscitation is mandatory prior to the induction of pneumoperitoneum to avoid haemodynamic compromise from the effects of increased intra-abdominal pressure in the hypovolaemic patient. There should be no hesitation in converting to a laparotomy if severe ongoing haemorrhage is identified or the source of bleeding cannot be identified or controlled laparoscopically.

Wound-Related Complications

Wound-related problems such as infection are uncommon after LS. Port-site hernias may develop at the site of ports larger than 10 mm [16, 17].

Prevention and Management Port-site hernias should be avoidable in most cases by meticulous closure of the fascia at the site of ports larger than 10 mm. Similarly, when the incisions are enlarged for extraction of the spleen, closure of the fascia is mandatory. Port-site hernias should be surgically repaired to eliminate the risk of intestinal obstruction or strangulation.

Cardiopulmonary Complications

Cardiac complications such as myocardial infarction, arrhythmias, and pulmonary complications such as left lower lobar atelectasis, pneumonia, pulmonary embolism

and pleural effusion are described after LS, but their overall incidence appears to be significantly lower than that after OS.

Prevention and Management The cardiac complications may be preventable by adequate assessment and optimisation of the medical comorbidities in the preoperative period. The pulmonary complications are minimised by aggressive attention to pulmonary care in the immediate postoperative period.

Subphrenic Collection and Abscess

Subphrenic collection and abscess formation is a well-known complication of OS, but occurs infrequently after LS. It may be an isolated complication or occur as a result of injury to an adjacent organ, especially in patients with a massively enlarged spleen. Any patient with an intermittent spiking temperature is suspected of having a subphrenic abscess. The diagnosis of intraperitoneal abscesses is difficult, resulting in a delay in treatment and poor prognosis. The chest X-rays may show pleural effusion, a raised hemidiaphragm or basal atelectasis. An abdominal CT scan is generally required in suspected cases to identify the location of the collection/abscess and to guide placement of percutaneous drainage catheters.

Prevention and Management Meticulous haemostasis during dissection of the spleen can help minimise postoperative oozing and the potential for abscess formation. Most surgeons do not advocate drainage of the left upper quadrant in patients undergoing splenectomy, but closed suction is mandatory when a large dead space persists. Percutaneous drainage under ultrasonographic or CT guidance is the preferred method for single well-localised, superficial abscesses that do not have fistulous communications or contain solid debris. Open drainage is reserved for abscesses for which percutaneous drainage is inappropriate or unsuccessful.

Fig. 7 A spleen weighing 3.5 kg removed by LS

Thrombosis of Splenic and/or Portal Vein

Postoperative thrombosis of the splenic vein can occur following splenectomy. This may occur more frequently than previously recognised. Up to 20% of patients may experience thrombosis of their splenic vein [18]. This condition may be asymptomatic, but could be associated with a vague abdominal pain. Ultrasonography or CT scan should be considered in all the patients with abdominal symptoms after splenectomy. Postoperative thrombosis of the portal vein (TPV) is a rare complication after splenectomy (Fig. 6). Because many patients remain asymptomatic, the true incidence of TPV may have been underestimated. In studies where routine postoperative ultrasonography was done after LS, the incidence of TPV ranged from 6.3 to 10% [19–22]. TPV after LS may be related to four major factors: (a) thrombocytosis, (b) blood stasis in splenic stump, (c) surgical manoeuvres or instruments associated with endothelial damage and (d) the underlying disease with the presence of splenomegaly. A possible cause of blood stasis within the splenoportal axis after LS may be the positive intra-abdominal pressure because of pneumoperitoneum. Ligation/control of the splenic vein close to the parenchyma with a long residual stump may favour blood stasis. During LS, hilar vessel coagulation and splenic dissection are performed close to the splenic parenchyma. Patients undergoing LS for myeloproliferative disorders, haemolytic anaemia, and thalassaemia or for an enlarged spleen carry a risk of 10–50% of developing postoperative TPV [23]. In patients with splenomegaly, this phenomenon may be due to the rapid drop of flow in a large splenic vein that occurs after surgical occlusion of the vessel. The splenic stump remains a low-flow conduit in which thrombosis may occur and it is favoured by the usual increase in the platelet count, which is proportional to the volume of the removed spleen. Splenic weight has been shown to be a significant factor predictive of postoperative thrombosis in the portal system. Patients with a spleen weighing >1 kg (Fig. 7) are 14 times more likely to develop TPV postoperatively [24].

Prevention and Management Some authors have proposed ligation of the splenic vein as close as possible to the mesenteric route as a preventive manoeuvre for portal and mesenteric thrombosis. This manoeuvre may not always be possible, neither necessary, as it increases the risk of bleeding. Patients with malignant haematological diseases and splenomegaly undergoing splenectomy require careful observation and prolonged thromboprophylaxis. Performing routine postoperative Doppler ultrasound to look for TPV seems prudent in the patients who are at a high risk for developing this complication. On detection of TPV, patients should receive systemic anticoagulation immediately because recanalisation may occur in more than 90% of patients with acute portal or

mesenteric vein thrombosis who are anticoagulated. Van't Riet et al. [25] demonstrated that all the patients treated within 10 days of the splenectomy had a resolution of the clot, whereas no patient in whom treatment was initiated more than 10 days after the splenectomy demonstrated clot resolution.

Postsplenectomy Sepsis

Individuals who have had splenectomy are at greater risk for developing overwhelming postsplenectomy sepsis as a result of decreased activity of the opsonins, decreased levels of IgM and decreased clearance of bacteria from the blood. Children are at greater risk for developing overwhelming postsplenectomy sepsis than adults, and fatal sepsis is more common after splenectomy for haematological disorders than after trauma [26]. The risk of sepsis is highest in the first year after splenectomy, and for adults, each subsequent year carries approximately 1% chance of developing sepsis. To date, no case of overwhelming postsplenectomy sepsis has been reported following LS.

Prevention Patients being scheduled for elective LS should be immunised with pneumococcal vaccine. This should preferably be administered two or more weeks before the operation [27]. Children under the age of 10 years and all the patients who are immunosuppressed or have an associated immunodeficiency should be vaccinated against pneumococcus, *Haemophilus influenzae*, meningococcus and hepatitis B. Most paediatricians believe that children who have had a splenectomy before the age of 5 years, should be treated with a daily dose of penicillin until the age of 10 years. The use of prophylactic penicillin is not advocated in children over the age of 5 years and in adults. All patients undergoing an emergency splenectomy should be immunised with pneumococcal vaccine postoperatively. In conclusion, surgeon undertaking LS should be aware of and guard against the common as well as uncommon complications. Proper case selection, adequate preoperative preparation including vaccination, meticulous and gentle surgical technique, and low threshold for conversion in the face of bleeding and diligent postoperative care would allow the surgeon to prevent and manage complications of LS successfully.

In conclusion, LS is an operation that carries many potential risks and surgeons undertaking it should be aware of them. Proper selection of cases, meticulous attention to intraoperative technical details and postoperative care with a vigilant eye for detecting complications early would go a long way in optimizing the outcome of this challenging operation.

Conflict of Interest None

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