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Diagnosis of Spleen Injury; Review Article

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Abstract

Background: A strong clinical assessment with a focused history, a mechanism of injury, and physical exam may provide a high index of suspicion for diagnosis, but a ruptured spleen can't always be ruled out from just a clinical assessment.**Objective:**This study aimed to diagnosis of Spleen Injury.**Conclusion**:Mini-laparoscopic splenectomy is particularly suited to pediatric and slender patients. A hidden umbilical incision can be used for introduction of the endovascular stapling device.

Key words:laparoscopic Splenectomy, Clinical diagnosis, Laparoscopic

Introduction:

The spleen is an **intraperitoneal**organ covered with peritoneum over its entire extent, except for a small area at its hilum, where the vascular structures and lymph nodes are located. The inferomedial surface of the spleen comes into contact with the stomach, left kidney, pancreas, and splenic flexure of the colon (Figure 1). The spleen lies in the posterior left hypochondrium between the fundus of the stomach and the diaphragm. The splenic axis is along the shaft of the eight to tenth ribs with the lower pole extending forward as far as the midaxillary line (Figure 1). The peritoneal ligament that attaches the spleen to the stomach and the kidney is called the *splenorenal ligament.* This ligament is in contact with the posterior peritoneal wall, the *phrenicocolic ligament,* and the *gastrosplenicligament*[(1)].

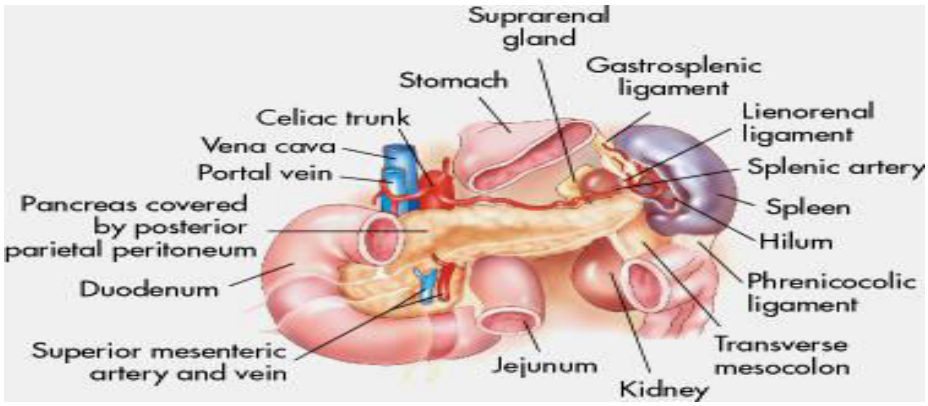

Fig. (1): Anterior view of the spleen as it lies in the left hypochondrium. Note the relational anatomy, ligament attachments, and vascular landmarks.

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Size

The spleen is of variable size and shape (e.g., "orange segment," tetrahedral, triangular) but generally is considered to be ovoid with smooth, even borders and a convex superior and concave inferior surface (see Figure 2). The spleen is normally measured with ultrasound on a longitudinal image from the upper margin (near the diaphragm) to the inferior margin at the long axis. Normal measurements for the average adult should be 8 to 13 cm in length, 7 cm in width, and 3 to 4 cm in thickness. The spleen decreases slightly in size with advancing age. The size of the spleen may vary in size in accordance with the nutritional status of the body[(2)]**.**

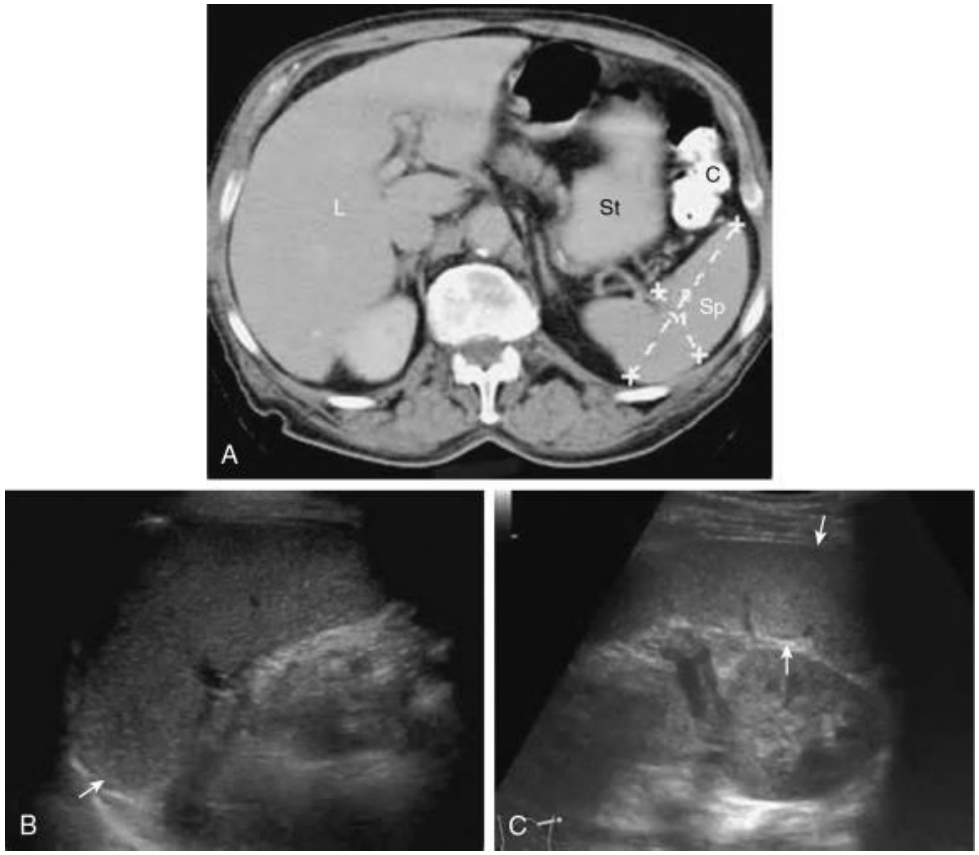

Fig. (2):A, Transverse CT image of the upper left quadrant demonstrates the posterior position of the spleen. *Sp,* spleen; *L,* liver; *St,* stomach; and *C,* colon.Transverse image **(B)** and longitudinal image **(C)** of the spleen with measurements.

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Clinical diagnosis of Spleen Injury

A strong clinical assessment with a focused history, a mechanism of injury, and physical exam may provide a high index of suspicion for diagnosis, but a ruptured spleen can't always be ruled out from just a clinical assessment. Ultrasound is an option but still cannot rule out a ruptured spleen adequately. If available, a CT scan is the best option for evaluating the abdomen and diagnosing a ruptured spleen in a clinically stable patient. The diagnosis is confirmed with CT in stable patients and with bedside (point of care) ultrasonography or exploratory laparotomy in unstable patients. CT scans can detect as little as 100 cubic centimeters of blood in the abdomen, an amount similar to about one-third of a can of soda[(3)]**.**

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Characteristics/Clinical Presentation

Signs and symptoms of a ruptured spleen include[4]:

- Pain (usually severe but not always) in the upper left portion of the abdomen or under rib cage.
- Tenderness when you touch the upper left portion of the stomach (abdomen). Coll's Sign
- Left shoulder pain (Kehr's Sign) - Pain in the left shoulder caused by irritation of the undersurface of the diaphragm by blood leaking from a ruptured spleen. The pain impulses are referred along the phrenic nerve supplying the diaphragm C3-C5 nerve distribution.

Types[5]

- laceration
- hematoma: subcapsular (more common) or intraparenchymal
- active hemorrhage
- pseudoaneurysm or AV fistulas (in ~15% of splenic trauma)
- splenic infarct (rare)

Investigations

Patients who are**haemodynamically unstable** with peritonism following trauma have abdominal bleeding until proven otherwise and require **immediate laparotomy**.

Those who are haemodynamically stable with suspected abdominal injury will need an **urgent CT chest-abdomen-pelvis with IV contrast** (Fig. 2)

CT imaging allows for the **identification and assessment of splenic injury***, alongside any other abdominal viscera involvement. Specifically, it also allows for the **grading of the splenic injury** to guide further management.

Focused assessment with sonography(FAST) scans in the emergency department setting can reveal free peritoneal fluid or fluid in the pericardium, however, whilst a potentially helpful adjunct, they should not delay CT imaging and/or surgical intervention[6].

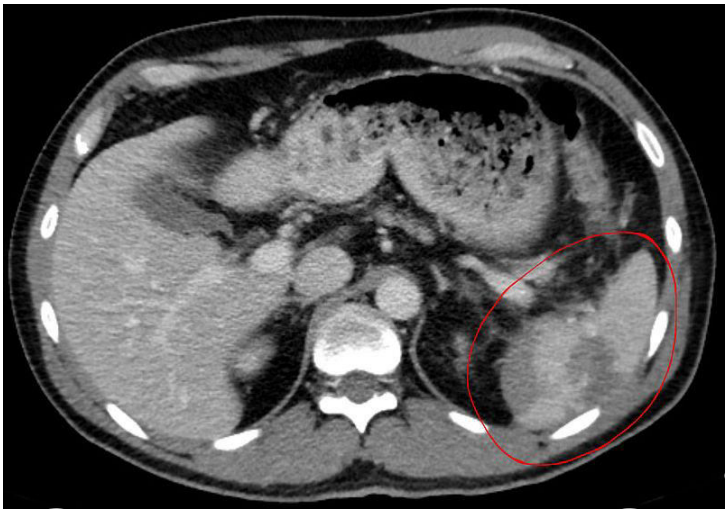

Fig. (2): A traumatic splenic rupture as seen on CT scan, the rim at the lower edge demonstrating a sign of free fluid (blood)

Diagnostic peritoneal lavage

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Diagnostic peritoneal aspiration (DPA) refers to the insertion of a catheter in the peritoneal cavity and aspiration of any fluid. Diagnostic peritoneal lavage (DPL) involves infusion of normal saline, lavage of the cavity, and macroscopic and microscopic evaluation of the returned fluid. DPA and DPL have largely been replaced by CT scan and abdominal ultrasound. However, in select cases it can provide quick information about intraperitoneal bleeding or infection. The most common trauma indication for DPA/DPL is suspicion of intraperitoneal bleeding in a hemodynamically unstable patient with a negative or equivocal ultrasound, who cannot undergo CT scan evaluation[(7)].

Laparoscopic Splenectomy

Laparoscopic splenectomy (LS) is the gold standard procedure to remove the spleen in elective patient, but remains a very delicate procedure due to fragility of parenchyma and capsule of the spleen and its close connections with stomach, pancreas and colon. Indications for LS have rapidly increased and it is now considered the standard approach for almost all diseases requiring splenectomy, including benign and malignant hematologic disorders and also non-hematologic malignancies also spleen injury, managed laparoscopically, are increasing over the years. An adequate learning curve and a standardized technique are necessary to reduce complications and conversion rate which however remain higher than those reported for most other advanced laparoscopic procedures[(8)].

Technique of Laparoscopic Splenectomy[(9)]:

1. Opening of lesser sac.
2. Division of the phrenocolic ligament, mobilization of the lower pole of the spleen
3. Control of the lower polar vessels (doubly clipped and ligated)
4. Division of the short gastric vessels with harmonic scalpel
5. Control of splenic artery between three clips proximally, two distally. Splenic vein similarly tackled
6. Division of the lineorenal and phrenosplenic ligaments
7. Use of a polythene bag to capture the spleen
8. Retrieval through the 10 mm port after finger fracture
9. Inspection of the splenic bed
10. Placement of a 14 French abdominal drain through the left lateral port if only there is oozing
11. 10 mm port site closure with No. 1 polypropylene; skin closure with nylon.

The patient is placed supine (Figure 3) or in the Fowler position if the surgeon prefers to stand between the patient's legs and a sandbag is then placed below the left hypochondrium and ribcage. After establishing pneumoperitoneum, the laparoscope is inserted in an umbilical port and explorative laparoscopy is performed[(9)].

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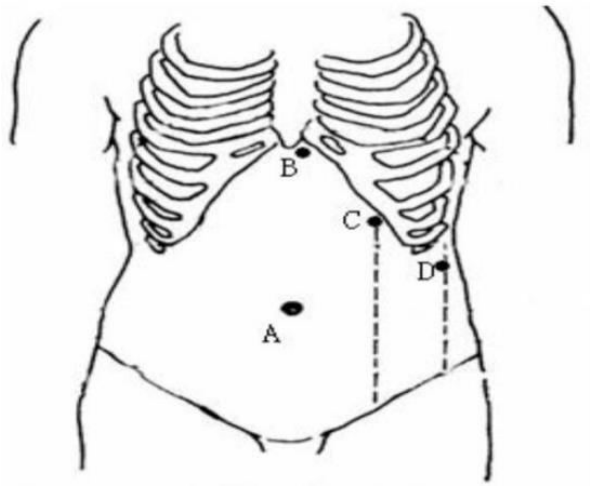

Fig. (3) : Showing port placement for anterior approach.

Trocars are then inserted in the subxiphoid, midepigastrium and the left ileac fossa. The scope is introduced through the midepigastric trocar; the subxiphoid area and umbilical ports are used for placement of grasping and dissecting instruments. The table is then placed in a right lateral tilt and reverse Trendelenburg position. After opening the omental pouch and dividing the short gastric vessels with clips or an endovascular stapler, a thorough search for accessory spleen begins at the tail of the pancreas and along the greater curvature of the stomach. Several techniques have been proposed for dissection of the splenic hilum. Splenic vessels can be controlled at the main trunk or a segmental devascularization near the splenic parenchyma can be performed. Once the main vessels have been divided and the pancreas dissected away, the remaining short gastric vessels can be controlled. Splenic flexure is then liberated and the posterior attachments to the spleen are sectioned until the viscera are completely freed. Advocates of this approach point out that the splenic artery can be accessed along the superior border of the pancreas within the lesser sac, thus securing vascular control early in the procedure[8].

Lateral Approach

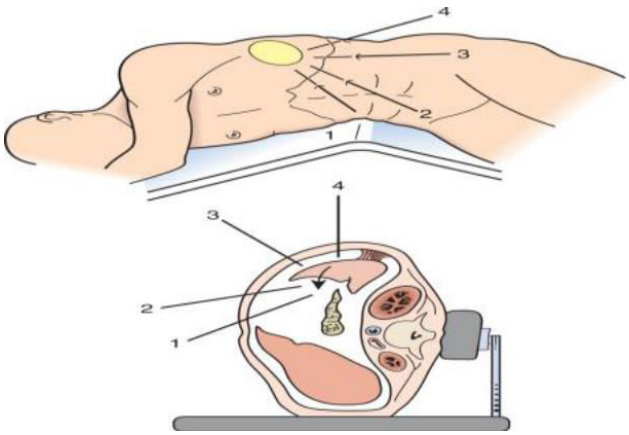

Fig. (4) : Strict lateral position of the patient for laparoscopic splenectomy

In Figure 4, the table is angulated, giving forced lateral flexion of the patient to open the costophrenic space. Trocars are inserted along the left costal margin more posteriorly. The spleen is

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hanged by its peritoneal attachments. The numbered lines show the position of laparoscopic ports. After induction of general anesthesia and endotracheal intubation, the patient is placed in a right lateral decubitus position at 60°. The table is broken 20°-30° below level in both the cephalad and caudad position. This maximizes the window of access between the patient's left iliac crest and costal margin. Video monitors are placed on each side of the patient's shoulders. The surgeon stands on the right side of the patient; the camera assistant is on the surgeon's left side and the first assistant is on the left of the patient. The patient is tilted in a 15° reverse Trendelenburg position. This allows the spleen to hang by its diaphragmatic attachments, thus acting as a natural counter traction while gravity retracts the stomach, transverse colon, and greater omentum inferiorly, and places the hilum of the spleen under tension. An open surgical tray is always available should the need for immediate conversion arise[(9)].

A carbon dioxide pneumoperitoneum created is maintained at 13 to 15 mmHg. Four 10- to 12-mm trocars are then inserted to allow a bimanual procedure. The position of the first trocar for the 30° telescope attached to a high-performance digital video camera is carefully chosen; low insertion of the trocar will hamper a direct view during dissection. As a rule of thumb, after creation of the pneumoperitoneum, if the distance between the umbilicus and the left costal margin exceeds the width of the hand, the position of this trocar is moved up toward the left costal margin. The next trocars used by the surgeon are placed around the telescope in a triangulated fashion at a 90° angle. A fourth trocar is placed in the anterior axillary line under the left costal margin and is reserved for the instruments of the first assistant. Sometimes added is a fifth subxiphoid trocar to allow retraction of an enlarged spleen or a prominent left hepatic lobe, or if hemorrhage occurs[(10)].

The abdomen is carefully explored for accessory spleens. This is done before the initiation of the dissection to avoid obscuring the surgical field with blood or irrigant. The stomach is retracted to the right and the gastro splenic ligament is inspected, then the splenocolic ligament, the greater omentum, and the phrenosplenic ligament. The left side of the mesentery, the mesocolon, and the pelvis, in the area of the left internal ring in both sexes and around the left adnexa in women, are checked. On opening the gastro splenic ligament, the splenic pedicle behind the pancreatic tail is inspected. The spleen is also evaluated for notching of the anterior border, which correlates with a distributed vascularization of the hilum, thus predicting the level of difficulty and the type of instruments used for hilar control[(9)].

The dissection proceeds in five stages: division of the short gastric vessels, division of the splenocolic ligament, ligation of the inferior polar vessels, hilar control, and division of the phrenic attachments of the spleen. The gastro splenic vessels are divided with four or five applications of the harmonic shears after retracting the gastric fundus. The splenocolic ligament is divided, leaving a bundle of connective tissue on the spleen that will be grasped by the first assistant, avoiding direct manipulation of the spleen and possible capsular fractures. Dissection proceeds medially and superiorly toward the splenorenal ligament while the spleen remains suspended from the diaphragm. The inferior polar branches are divided using clips or the harmonic shears. Segmental devascularization changes the color of the spleen from brown to blue and allows the surgeon to follow the progress of the procedure[(11)].

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Gentle retraction of the mobilized inferior pole of the spleen exposes the hilar groove, and the vascular distribution of the hilum is evaluated. In the distributed mode, each terminal branch is divided between clips. In the magistral mode, the pedicle formed by the artery and vein enters the hilum as a compact bundle and is transected en bloc with a single application of a 3-cm linear laparoscopic stapler. Once the hilum has been controlled, the remaining short gastric vessels at the superior pole of the spleen and the ligamentous phrenic attachments are divided with the harmonic shears, completing the splenic mobilization. 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 left lateral trocar is removed and a puncture-resistant retrieval bag is introduced through this site as shown in Figure 5 [(11)].

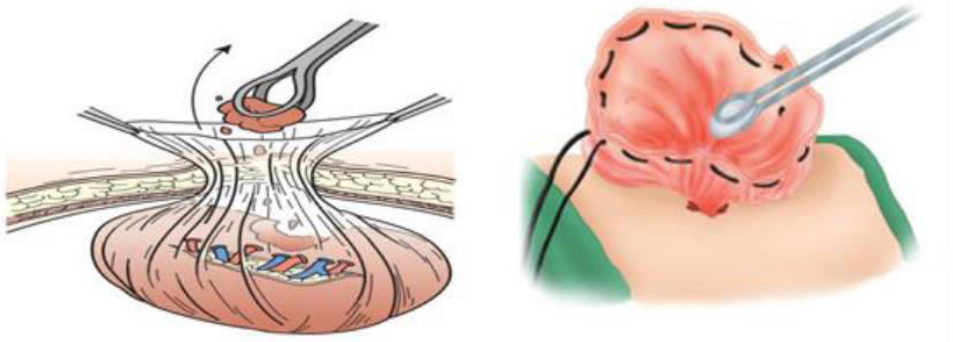

Fig. (5) : Extraction of specimen.

The trocar is then replaced. The bag is directed toward the diaphragm and is held open facing the telescope. The patient is placed in a slight Trendelenburg position to facilitate the introduction of the spleen into the bag while grasping the hilar connective tissue. The sack is introduced and unfurled, then maneuvered over the relatively immobile spleen. The final splenophrenic attachments are then divided and the drawstring on the sack is closed. The neck of the sack is withdrawn through the supraumbilical trocar site. Within the sack, the spleen is morcellated with ring forceps and extracted piecemeal taking great care to insure that the bag is not ruptured is necessary to avoid intraabdominal contamination from splenic material and subsequent splenosis. Also, during all manipulations, care is taken to avoid spillage of splenic fragments between the sac and the umbilical incision. Once the entire specimen and sack have been removed, a final laparoscopic survey and irrigation are performed. In the event that it is necessary to extract the spleen intact (as in staging for Hodgkin's disease), an accessory incision must be used, which can be made in various locations on the abdomen or through the widening of a trocar incision. A Pfannestiel or umbilical incision can be made as well. The use of a posterior culpotomy has also been suggested as a means by which the specimen may be extracted. If a concomitant procedure such as cholecystectomy is to be performed, the patient will need to be rolled supine and to have another (2 mm or 5 mm) port introduced into the right upper quadrant[(9)].

The advantages of lateral approach over anterior approach include improved exposure of and access to the splenic pedicle. Also, the mechanics and sequence of dissection are enhanced and more intuitive to the surgeon using this approach. The tail of the pancreas is more easily identified and, therefore, less likely injured using the lateral approach to LS. A drawback to this approach is

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the frequent necessity to reposition the patient when concomitant laparoscopic cholecystectomy is to be performed following completion of the laparoscopic splenectomy[11].

Complications of Laparoscopic Splenectomy

Surgical complications of laparoscopic splenectomy are similar to those for the "open" procedure. Early complications include bleeding, pneumonia, left pleural effusions, atelectasis, and injury to other organs (colon, small bowel, stomach, liver, and pancreas). Late complications include subphrenic abscess, splenic or portal vein thrombosis (or both), failure of the procedure to control the primary disease, recurrent disease as a result of accessory spleens, and OPSI. Independent of any complications inherent to laparoscopic surgery in general (e.g., related to pneumoperitoneum injuries from trocars), LS 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 from three sources: a small caliber vessel (short gastric or polar vessels), a larger vessel of the hilum, or the splenic parenchyma. Other complications reported with LS include deep vein thrombosis, pulmonary embolus, and wound infection. It is interesting to note that there is a remarkably low incidence of deep surgical infection or subphrenicabscess[9].

The clavien-dindo grading system for surgical complications[12].

Grade I: Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic and radiological interventions. Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgesics, diuretics and electrolytes and physiotherapy.

Grade II: Requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included.

Grade III: Requiring surgical, endoscopic or radiological intervention

Grade III-a: Intervention not under general anesthesia

Grade III-b: Intervention under general anesthesia

Grade IV: Life-threatening complication (including CNS complications: brain hemorrhage, ischemic stroke, subarachnoid bleeding, but excluding transient ischemic attacks) requiring IC/ICU management.

Grade IV-a: Single organ dysfunction (including dialysis)

Grade IV-b: Multi-organ dysfunction

Grade V: Death of a patient

Suffix'd': If the patients suffer from a complication at the time of discharge, the suffix "d" (for 'disability') is added to the respective grade of complication. This label indicates the need for a follow-up to fully evaluate the complication as shown in Table 2. [12].

Table 2: Complications of the procedure.

Complications	Clavien type	Technique related
Hemorrhagic		
Abdominal wall hematoma	I	Yes
Subdiaphragmatic hematoma	IIa	Yes
Hemoperitoneum	IIb	Yes

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Hemopneumothorax	IIb	Yes
Lung		
Atelectesis	IIa	No
Pneumonia	IIa	No
Upper airway Infection	I	No
Fever and lung tuberculosis	II	No
Septic		
Wound sepsis	I	Yes
Catheter Sepsis	II	No
Urinary infection	I	No
Others		
Sweet Syndrome	II	No
Gout attack	I	No
Hypophyseal insufficiency	II	No
Postoperative ileus	I	No
Diaphragmatic perforation	II	Yes

Basic problems during laparoscopic splenectomy and their management

Laparoscopic splenectomy is a technically challenging procedure and this can be handled by learning and practicing the proper technique. The instruments we use should be up-to-date and properly maintained so that the procedure is smooth without any complications. One more common difficulty is securing the vascular pedicle and there are various instruments and techniques for this. One should use the method in which he/she is fully confident. Removal of a large spleen poses problems and this can be taken care of by an additional incision. Rare complications like port site herniation and sub-acute intestinal obstruction can also occur[(8)].

Conclusion: Mini-laparoscopic splenectomy is particularly suited to pediatric and slender patients. A hidden umbilical incision can be used for introduction of the endovascular stapling device.

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