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Review Article

Laparoscopic splenectomy

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ABSTRACT

Laparoscopic splenectomy is now becoming the procedure of choice for elective splenectomy wherever the expertise is available. Initially laparoscopic Splenectomy was performed only for benign hematological conditions, but now with the advancement of technology its use has been extended to massive splenomegaly, other benign conditions and infective pathologies of the spleen and also in cirrhosis of liver with portal hypertension. Extensive search has been made on internet websites. Reasons for review are the paucity of literature, wide acceptance to the procedure as the method of choice for elective splenectomy, to assess the feasibility of the procedure and also to expand the uses of laparoscopic splenectomy.

Keywords: Laparoscopy, Splenectomy

INTRODUCTION

The first splenectomy was performed by Andirano Zaccarello in 1549 on a young woman with an enlarged spleen who survived for 6 years after surgery.[1] Quittenbaum performed the first successful splenectomy in 1826 for hematological disorder.[2] In the late 1980s, the advent of minimally invasive procedures used in a new era in patient management. With advent of laparoscopy, it has become standard procedure for elective splenectomy since the first report of laparoscopic splenectomy by Delaitre and Maignen in 1991.[3] The first laparoscopic splenectomy in children was performed in 1993 by Tulman.[4]

In 1992, Carrol, Philips, Semal, Fellas and Morgenstern of Cedars-Sinai medical center reported three cases of successful laparoscopic splenectomy.[5] The same year many teams around the world reported similar cases. Since then laparoscopic splenectomy is fast gaining a strong foothold for management of the many afflictions of the spleen. Potential benefits of a minimally invasive approach include reduced blood loss, better pain control, decreased perioperative morbidity, and shorter hospital length of stay.[6]

With the recent successes of laparoscopic splenectomy in selected cases, the future of splenic surgery will undoubtedly bring many more changes. Laparoscopic splenectomy can be safely performed and have gained wide clinical practice today. It leads to decrease in complication related to trauma, access to magnified view of the opposite side and avoidance of manipulation of left side of diaphragm. With advancement of laparoscopy and technology laparoscopic approach is routinely considered for patients requiring elective splenectomy regardless of spleen size.[7]

Laparoscopic approach to diseases related to solid organ such as spleen and liver has lagged behind operations on hollow viscous because of problems related to hemostasis and extraction of specimen. It also entails difficulty because of frail nature of spleen and complex vasculature.[8] Another approach towards Natural Orifice Trans luminal Endoscopic Surgery is Single incision Laparoscopic Procedure. Loss of requirement of any of visceral organ and endoscopic equipment make this technique more popular and easily performable.[9]

Laparoscopic splenectomy has already started into many centers in India. Qualified surgeons and the necessary equipment are at par with their world class counterparts. A team of dedicated hematologists, surgeons, anesthetists, contribute towards successful patient outcome. The other important issue will be reduction of costs. Apart from shorter hospitalizations, the only way to cut costs will be development of indigenous equipment wherever feasible for example retrieval bags. Technological advances are indispensible for instance the ultrasonic activated scalpel/vascular staples, which have improved operating time without compromising patient safety.

Reasons for present review are the paucity of literature with wide acceptance to the procedure as the method of choice for elective splenectomy.

ANATOMY OF SPLENIC VASCULATURE

Like snowflakes no two spleens are identical. The important anatomical aspects of the spleen are its vascularization and its great number of relationships with adjacent organs (Figure 1). For successful laparoscopic splenectomy, the surgeon should be familiar with the three dimensional relations of the spleen and be conversant with the variations of the blood supply. The spleen being a reticuloendothelial organ is soft, friable and deserves careful handling by the surgeon as well as the assistants. Despite the fragility of the splenic parenchyma, its capsule is solid and can be manipulated without rupture if handled with care. Capsular tears can lead to bleeding, splenosis, and conversion into open.

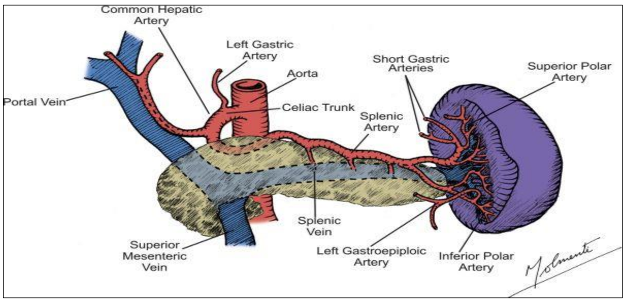

Figure 1: Blood supply of spleen.

The spleen has in essence a double blood supply: short gastric vessels and a main hilar vascular trunk. Although highly variable, splenic artery anatomy has been classified more simply into two patterns: magistral and distributed.[10] The commoner distributed type found in around 70% of the dissections and the magistral type found in the rest. By definition, in the distributed type, the trunk is short and many long branches (6-12) enter over three fourths the medial surface of the spleen. The branches originate 3 to 13 cm from the hilum (Figure 2a and 2b).

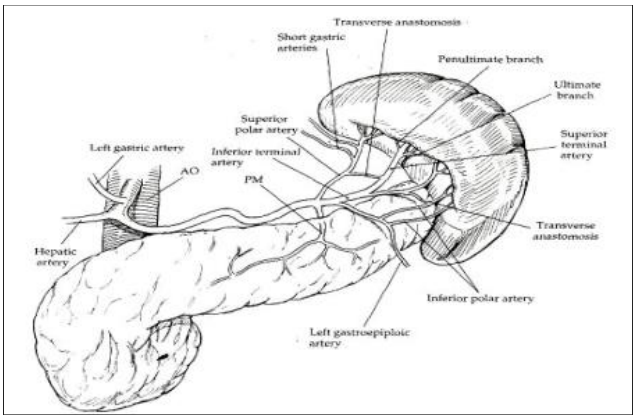

Figure 2a: Distributed pattern.

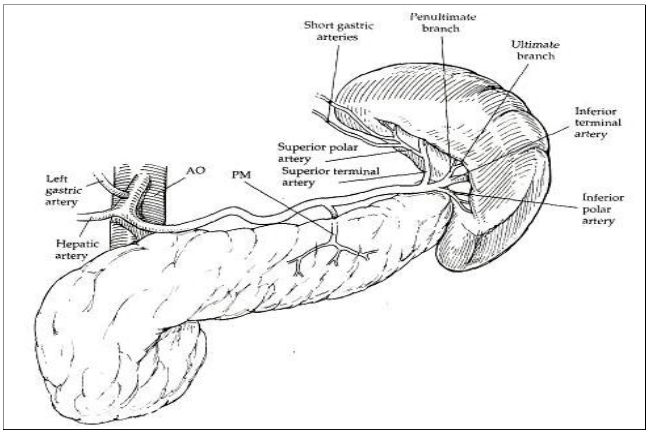

Figure 2b: Magistral pattern.

The magistral type is characterized by the presence of a long main splenic artery that divides into short terminal branches near the hilum. In this type, splenic branches enter over only one-fourth to a third the surface of the spleen. These branches are few (3-4) and large, originate on an average 3.5 cm from the spleen and reach the center of the organ as a compact bundle. There are also accessory polar vessels and anastomoses with gastroepiploic vessels. These anatomic details require that the surgeon be completely familiar with variable and anomalous extrasplenic vascular anatomy. The more the number of notches on the spleen, the more is a segmental distributed pattern of blood supply likely. Accessory spleens are more likely with this pattern of blood supply. Choice of vascular control utilized depends to an extent on the pattern of branching. In the distributed type, each large branch should be dissected out individually and controlled separately. In the magistral type, the main trunk can be controlled just proximal to its branches using a vascular stapler. Figure 3 depicting arterial division of splenic artery.

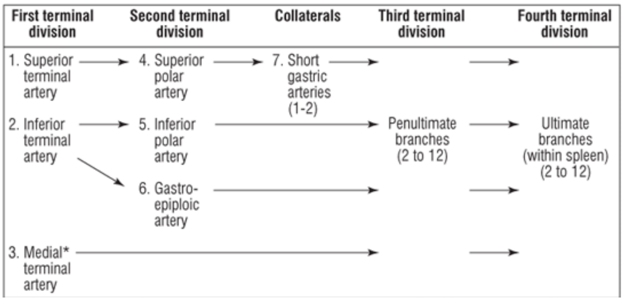

Figure 3: Arterial division of splenic artery.

IMPORTANT SURGICAL FEATURES OF SPLENIC ANATOMY

1] No two spleens have the same anatomy. 2] Two types of splenic blood supply exist: magistral and distributed. 3] Transverse anastomosis exists between the splenic artery branches. 4] The gastro splenic ligament contains short gastric and gastroepiploic vessels. 5] The lienorenal ligament contains the hilar vessels and the tail of the pancreas. 6] Other suspensory Ligaments are avascular, except in portal hypertension and myeloid metaplasia.7] The tail of the pancreas lies within 1 cm of the inner surface of the spleen in 73% of patients The tail of the pancreas is in direct contact with the spleen in 30% of patients. 8] The size of the spleen does not determine the number of entering arteries. 9] The presence of notches and tubercles correlates with a greater number of entering arteries. 10] If splenic artery embolization is used, it should be done distal to the great pancreatic artery.

TECHNIQUE OF LAPAROSCOPIC SPLENECTOMY

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.

If required additional incision or port can be placed for removal of spleen and additional procedure. Various photographs showing steps of laparoscopic splenectomy as shown in Figure 4.

VARIOUS STEPS IN LAPAROSCOPIC SPLENECTOMY

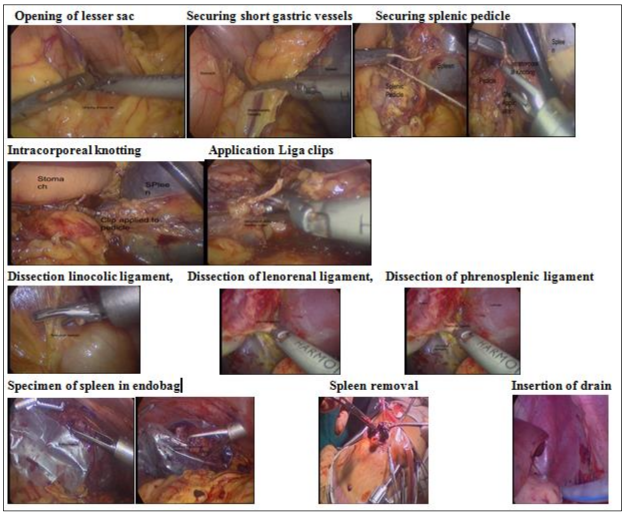

Figure 4: Various steps of laparoscopic splenectomy.

Various approaches was described for laparoscopic splenectomy by the different authors.[11-16]

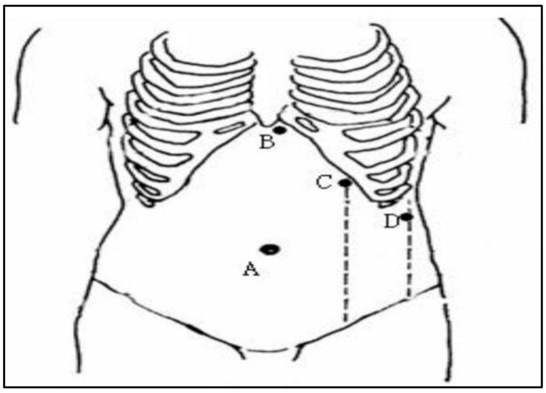

Figure 5: Showing port placement for anterior approach.

The patient is placed supine (Figure 5) 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.

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. Also, when concomitant laparoscopic cholecystectomy is indicated in a patient undergoing laparoscopic splenectomy, no repositioning of the patient between procedures is required.

LATERAL APPROACH

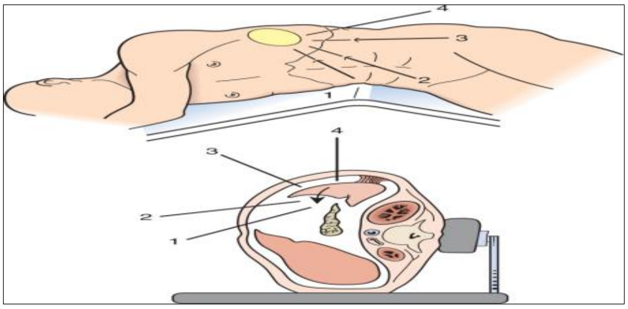

Figure 6: Strict lateral position of the patient for laparoscopic splenectomy.

In Figure 6, 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 hanged by its peritoneal attachments. The numbered lines show the position of laparoscopic ports[16].

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.

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.

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.

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.

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.

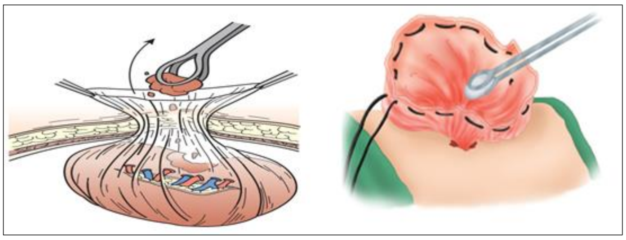

Figure 7: Extraction of specimen.[17-19]

The left lateral trocar is removed and a puncture-resistant retrieval bag is introduced through this site as shown in Figure 7. 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.

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 the frequent necessity to reposition the patient when concomitant laparoscopic cholecystectomy is to be performed following completion of the laparoscopic splenectomy.[18,19]

THE SPLENIC HILUM AND HEMORRHAGE[20-22]

Skeletonizing the vessels allow for clipping smaller vessels but do not afford an advantage when using a linear stapling device. Should significant hemorrhage occur during division of the hilar vessels, a clear understanding and exposure to the remaining vascular attachments can make the difference between continuing laparoscopically and converting to an open procedure? Thus, before dividing the hilum, the spleen is completely mobilized while retaining a small superior pole splenophrenic attachment.

Advances in linear stapling devices have enhanced laparoscopic splenectomy. In general, 2.5-mm vascular loads are sufficient for hemostasis, but 2.0-mm staple loads are used for thin pedicles and skeletonized vessels. A large spleen dictates an approach to the hilum through less than optimal port placement. The tail of the pancreas should be well visualized to avoid inadvertent injury. Hemorrhage is the most common cause for conversion during laparoscopic splenectomy. A judiciously placed grasper can control the hemorrhage, allowing deliberate suctioning and dissection, rather than blind placing of clips that may cause more bleeding or jam subsequent stapler function. An additional port can also make the difference between continuing laparoscopically and converting to laparotomy. Back bleeding from the spleen can be difficult to identify because of vessel retraction into the spleen and additional parenchymal damage from clips placed to control bleeding. In situations such as this, it is best to progress steadily and expeditiously through the division of the remaining hilum, focusing on control of any bleeding from the proximal side.

Since the majority of injuries occur at the apex of the staple lines, additional tension on the hilum will often lift a point of bleeding in line with the next staple load, providing rapid hemostasis with firing. The completeness of division of vascular attachments can be demonstrated by manipulating the spleen medially and laterally.

OTHER LS TECHNIQUES[23,24]

Hand-assisted LS has been suggested as a means by which LS can be more safely and expeditiously performed. Using this technique the surgeon's left hand (left-handed surgeons may choose to insert their right hand) is completely introduced into the peritoneal cavity. This allows for identification and division of appropriate tissues by palpation under direct laparoscopic visualization. The size of incision required to admit the surgeon's hand may mitigate the advantages of this approach. 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. This results in improved cosmoses as well as better functional recovery.

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. The first type of hemorrhage, though not life threatening, can become quite a hindrance to the operation, as rapidly accumulating blood may impair vision. This hemorrhage, however, can also easily be stopped with the use of clips, electrocoagulation, or the ultrasonic dissector. Hemorrhage from a larger vessel may be an indication for immediate conversion to laparotomy. The best means for its prevention is 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. Injury to these vessels can occur simply due to the rigidity of the clamping instruments. Hemorrhage originating in the parenchyma is less dangerous and can be managed by clamping the artery or by applying slight pressure with gauze, as well as by the use of electrocoagulation. Another potential complication of LS 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 LS allows the splenic hilum to lengthen, which permits the endostapler to be used without risk of causing harm to the pancreatic tail. A further possible complication of LS 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 by the use of a pleural drain. 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 subphrenic abscess.

DESCRIBING THE CLAVIEN-DINDO GRADING SYSTEM FOR SURGICAL COMPLICATIONS

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. This grade also includes wound infections opened at the bedside.

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 1.

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.

Table 1: Complications of the procedure.

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

Rare complications like port site herniation and sub-acute intestinal obstruction can also occur.

Despite the current marked reduction in OPSI-related mortality, an alarming number of "vaccine failures" have been noted. OPSI developed in 41% of patients in one trauma series, despite the fact that these patients received appropriate vaccines after splenectomy.[25] Nonetheless, vaccination of asplenic patients against encapsulated organisms has value when applied to the population as a whole. The most common causal organism, accounting for as many as 50 to 90% of all OPSI cases, remains pneumococcus. Meningococcal, H. influenza type B, group A streptococci follow in order of frequency.[26]

Following are the various studies performed by the different authors as depicted in Table 2, 3, 4 and 5 regarding platelet counts, important variables, and perioperative complications and accessory spleens and laparoscopic versus open splenectomy.

Table 2: Comparison of preoperative and postoperative platelet count in various studies.

Studies	Pre-operative platelet count (u/ml)	Post-operative platelet count (u/ml)
Berman R et al. (2004)[28]	97000	141000
Machado NO et al. (2010)[38]	28000	180000
Golash V et al. (2011)[40]	15000-45000	>30000
Hasan Ucmak et al. (2013)[46]	56000	222000
Fernandale L et al. (2013)[44]	34000	287000

Table 3: Important variables of laparoscopic splenectomy in different studies.

Studies	No. of patients	Years of study	Preoperative splenic diameter (cm)	Mean blood loss (ml)	Mean operating time (min)	Mean splenic weight (gm)	Mean postoperative stay (days)
Katkhouda et al.[49] (1998)	103	6	14	NA	161	263	2.5
F. Romano et al.[50] (2002)	10	5	16	80	120	485	3.5
Sapuchay M et al.[52] (2003)	30	8	NA	NA	261	NA	5.1
Hyun Chaw Kyon et al.[51] (2005)	30	5	NA	NA	117.5	NA	4
Dalvi AN et al.[29] (2005)	26	6	NA	170	214	942	5.65
Quereshi FG et al.[31] (2005)	81	12	NA	61	231	308	2.4
Bell et al.[53] (2005)	109	9	NA	308	159	512	4
Silecchia G et al.[54] (2006)	76	9	13.7	NA	143	NA	5.5
Golash V et al.[40] (2010)	19	7	14	45	152	250	7
Patle N et al.[35] (2010)	49	3	18.4	73.8	124	1038	4.7
Maurio M et al.[41] (2010)	86	9	NA	NA	160	NA	3.2
Kamlesh P et al.[37] (2010)	21	NA	20	140	160	900	4
Machado N et al.[38] (2010)	12	3	Na	70	126	160	4
Fernadale et al.[44] (2013)	20	2	NA	106	100	119	4

Table 4: Perioperative complications and accessory spleens in various studies.

Study	Perioperative complications,	% of patients	Accessory spleen and patients %
Hyuk Chan Kwon et al.[51] (2005)	Intraoperative Subphrenic abscess and wound haematomas	0% 10%	16.7%
AN Dalvi et al.[29] (2005)	Procedure converted to open due to hemorrhage Subphrenic abscess Postoperative sepsis	11.5% 3.84% 3.84%	7.69%
Bell et al.[53] (2005)	Procedure converted to open due to hemorrhage Postoperative complication include left lower lobe pneumonia and wound infection	15.8% 16%	NA
Mauricio Macedo et al.[41] (2010)	Intraoperative bleeding prompting to conversion Diaphragmatic Injury Pneumothorax PVT	6% 1.6% 1.6% 1.6%	11%
Golash V[40] (2010)	None and oral intake on POD 1	0%	15.78%
Patle N et al.[35] (2010)	Procedure converted to open due to hemorrhage Port site infection	2% 4%	12%
Machado Neil et al.[38] (2010)	Procedures converted to open Oral started on day 1 Intraoperative complications Sbphrenic abscess and jejunal segment gangrene PVT	0% 0% 16% 8.75%	NA
L. Fernadale et al.[44] (2013)	None and oral intake immediately started after patient is awake. Post-operative porto-venous thrombosis	0% 10%	NA

Table 5: Comparison of laparoscopy and open approaches.

Study	N	Approach	Mean operating time (min)	Hospital stay	Intraoperative and postoperative complication rate
Adrian Park et al.[5] (1999)	147 63	Laparoscopic Open	145 77	2.4 9.2	10.2 34.9
Jaffar AL-Khuzaie et al.[27] (2002)	7 7	Laparoscopic Open	182 165	7.2 12.7	Less blood loss and transfusion required in laparoscopic group
Sapuachy et al.[52] (2003)	30 28	Laparoscopic Open	261 183	5 7	33.33% 66.66%
Zhu J et al.[42] (2010)	79 66	Laparoscopic Open	-	-	13.6% 41.2%

NA = Data not available

Thus it is evident that open splenectomy though requires lesser operating time, complication rate, postoperative stay are lesser in laparoscopic group and since a major laparotomy incision is avoided wound related complications, analgesia requirement is less and procedure is also cosmetically better.

Laparoscopic splenectomy lacks long term follow up single institutional study with large number of patients prospectively. Such studies need to be carried out in institutes were hematological specialized centers are available for large number of referrals and postoperative care.

A method of securing splenic pedicle needs to be analyzed in detail with proper randomization for cost effectiveness. In our study we observed use of vessel sealer with shorter operative time and blood loss. With use ligature as studied by Fernadale et al.[46] similar comparative studies with simple intracorporeal knotting and Liga clips and harmonic scalpel need to be done for time and cost effectiveness.

With increasing technology and newer methods laparoscopic splenectomy can be performed for massive spleen and have been studied as by Grahn S et al.[9] Our study lacks relation of splenic size and weight with complications. Pallenivalu 2001 have reported three fourth of their series of splenctomies being performed for large spleens. In our series 12 patients had spleens more than 500gms.This is in support that with increasing experience and technology large spleens are no longer contraindications for laparoscopic splenectomies.

Our study has been performed in aterolateral approach which has advantages of easily performing concomitant procedure and better visualisation of splenic pedicle. Posterolateral approach is not used. Certain literature describes it better as by Bai Ji et al.[14] All patients in our study were for benign splenic disorders.

With path toward Natural orifice traluminal endocscopic surgeries, SILS has studied by Pędziwiatr1 et al.[48] Comparative study with laparoscopic splenectomies for feasibility and large spleens are required.

Laparoscopic splenectomy though has a definitive learning curve, is not difficult if one has experience in open splenectomy. The practice of earl ligation of splenic artery facilitates the laparoscopic splenectomy and decreases the chance of conversion to open surgery. Overall the study on laparoscopic study reveals that laparoscopic splenectomy can be done for varied indications and is feasible in our settings with acceptable morbidity and mortality. However further long term results and meta-analysis required regarding the efficacy and safety of laparoscopic splenectomy for massive spleen and malignant hematological conditions.

CONCLUSION

Rapid advances in technology and improvement in non-invasive imaging tests, laparoscopic splenectomy is now being advocated for massive splenomegaly also. It has shorter operative time and recovery period and excellent cosmetic results as compared to the open technique. Laparoscopic splenectomy though has a definite learning curve, is not difficult if one has experience in open splenectomy. Advanced laparoscopic instruments like harmonic scalpel, endoscopic vascular stapler, ligature and hand port aid the surgeons in removing large spleens and also spleens in portal hypertension.

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REFERENCES

1. Coon WW. The spleen and spelenectomy. Surg Gynecol Obstet. 1991 Nov;173(5):407-14.
2. McClusky DA III, Skandalakis LJ, Colbom G, Skandalakis JE. Tribute to a tried: history of splenic anatomy, physiology and surgery-part 1. World J Surg. 1999 Mar;23(3):311-25.
3. Delaitre B, Maignien B, Icard PH. Laparoscopic spelenectomy. Br J Surg. 1992;79:1334.
4. Tulman S, Holcomb GW, Karamanoukian HL, Reynhout J. Laparoscopic spelenectomy. J Pediatr Surg. 1993;28:689-92.
5. Carroll BJ, Phillips EH, Semel CJ. Laparoscopic spelenectomy. Surg Endosc. 1992;6:183-5.
6. Flower JL, Lefor AT, Steers J. Laparoscopic spelenectomy in patients with hematologic diseases. Ann Surg. 1996 July;224(1):19-28.
7. Sotomayor-Ramires RK. Efficacy and safety of laparoscopic spelenectomy. Bol Asoced P R. 2009 Jun;101(2):43-9.
8. Park A, Marcaccio M, Sternbach M, Witzke D, Fitzgerald P. Laparoscopic vs. open spelenectomy. Arch Surg. 1999;134:1263-9.
9. Targarona EM, Espert JJ, Cerdan G, Balagué C, Piulachs J, Sugrañes G, et al. Effect of spleen size on spelenectomy outcome. A comparison of open and laparoscopic surgery. Surg Endosc. 1999;13:559-62.
10. Dixon JA, Miller F, McCloskey D. Anatomy and techniques in segmental spelenectomy. Surg Gynecol Obstet. 1980;150:516.
11. BaiJi Y, Yingchao W, Ping Zhang. Anterior versus poster lateral approach for total laparoscopic splenectomy: a comparative study. Int J Med Sci. 2013;(10):222-30.
12. Kuriansky J, Benchaim M, Rosin D, Haik J, Zmora O, Saavedra P, et al. Poster lateral approach. An alternative strategy in laparoscopic spelenectomy. Surg Endosc. 1998 Jun;12(6):898-900.

13. Park A, Gagner M, Pomp A. The lateral approach to laparoscopic spelenectomy. Am J Surg. 1997;173:126-30.
14. Gossot D. Laparoscopic splentomy, value of the posterior approach. Ann Chir. 1998;52(9):940-5.
15. GagnerM, Lacroix A, Bolte E, Pomp A. Laparoscopic adrenalectomy. The importance of a flank approach in the lateral decubitus position. Surg Endosc. 1994;8:135-8.
16. Gigot JF, Lengele B, Gianello P, Etienne J, Claeys N. Present status of laparoscopic splenectomy for hematologic diseases: certitudes and unresolved issues. Semin Laparosc Surg. 1998;5:147-67.
17. Gentilli S, Velardocchia M, Ferrero A, Martelli S, Donadio F. Laparoscopic splenectomy. How to make it easier using an innovative atraumatic suction grasper. Surg Endosc. 1998 Nov;12(11):1345-7.
18. Lai PB, Leung KL, Ho WS. The use of Liposuker for spleen retrieval after Laparoscopic splenctomy. Surg Laparosc Endosc Percutan Tech. 2000 Feb;10(1):30-40.
19. Park AE, Gagne M, Pomp A. The lateral approach to laparoscopic splenectomy. Am J Surg. 1997;173:126.
20. Crushieri A, Shumi S, Banting S. Technique aspects of laparoscopic splenectomy. Hilar segmental devascularisation and instrumentation. JR Coll Surg Edinb. 1992;37(6):414-6.
21. Gossot D, Frictsch B, Colerier M. Laparoscopic splenectomy: optimal. Surg Endosc. 1999 Jan;13(1):21-5.
22. Schaarschmidt K, Kolberg SA, Lempe M. Ultrasonic shear coagulation of main hilarvessels; A 4 year experience of 23 pediatric laparoscopic splenectomies without staples. J Pediatr Surg. 2002 Apr;37(4):614-6.
23. RoRomanelli JR, Kelly JJ, Litwin DE. Hand assisted laparoscopic surgery in the United States: an overview. Semin Laparosc Surg. 2001 Jun;8(2):96-103.
24. Targarona EM, Balague C, Trias M. Hand assisted laparoscopic splenectomy. Semin Laparosc Surg. 2001 Jun;8(2):126-34.
25. Reinert RR, Kaufhold A, Kahnemund O, Lütticken R. et al. Serum antibody responses to vaccination with twenty three valent pneumococcal vaccine in splenectomized patients. Zentralbl Bakteriol. 1994;281:481-90.
26. Brigden ML, Pattullo AL. Prevention and management of overwhelming postsplenectomy infection an update. Crit Care Med. 1999;27:836.
27. Khuzaie JA, Dayna KB, Wahab A. Laparoscopic, splenectomy versus conventional splenecomy. Bahrain Med Bull. 2002;24(2):91-5.
28. Berman RS, Feig BW, Hunt KK. Platelet Kinetics and decreased transfusion requirements after splenectomy for hematologic malignancy. Ann Surg. 2004;240:852-7.
29. Dalvi AN, Thapar AN, Deshpande PM, Rege AA, Prabhu RY, Supe AN, et al. Laparoscopic splenectomy using conventional instruments. J Minim Access Surg. 2005 Jun;1(2) 63-9.
30. Grahn SW, Alvarez J, Kirkwood K. Trends in laparoscopic splenectomy for massive splenomegaly. Arch Surg. 2006:141:755-62.
31. Qureshi FG, Ergun O, Sandulache VC. Laparoscopic splenectomy in children. J Soc Laparoendosc Surg (JSLS). 2005;9:389-92.
32. Pattenden CJ, Mann CD, Metcalfe MS. Laparoscopic splenectomy: a personal series of 140 consecutive cases. Ann R Coll Surg English. 2010 July;92(5):398-402.
33. Dzieicki J, Grabowski A, Korlacki W. Optimizing the technique of laparoscopic splenectomy in children. Videosurg Miniivas Tech. 2010;5(1):19-26.
34. Habermalz B, Sauerland S, Decker G, Delaitre B, Gigot JF, Leandros E, et al. Laparoscopic splenectomy: the clinical practice guidelines of the European Association for Endoscopic Surgery (EAES). Surg Endosc. 2008 Apr;22(4):821-48.
35. Patle NM, Tantial O, Sasmal PK. Laparoscopic splenectomy in patients of beta thalassemia: our experience. J Minim Access Surg. 2010 Sep;6(3):70-5.
36. Koshenkov VP, Pahuja AK, Nemeth ZH. Identification of accessory spleens during laparoscopic splenectomy is superior to preoperative computed tomography for detection of accessory spleens. J Soc Laparoendosc Surg (JSLS). 2012;16:387-91.
37. Pal K. Modified port placement and pedicle first approach for laparoscopic concomitant cholecystectomy and splenectomy in children. J Indian Assoc Pediatr Surg. 2010;15(3):93-5.
38. Machado NO, Al Kindy N, Chopra PJ. Laparoscopic splenectomy using LigaSure. J Soc Laparoendosc Surg (JSLS). 2010;14:547-52.
39. Hyodo M, Sata N, Koizumi M, Sakuma Y, Kurihara K, Lefor AT, et al. Laparoscopic splenectomy using pneumoperitoneum or gasless abdominal wall lifting: a 15 year single institution experience. Asian J Endosc Surg. 2012 May;5(2):63-8.
40. Golash V. The role of pre-emptive control of vascular pedicle in laparoscopic splenectomy. Oman Med J. 2011;26(2):136-40.
41. Macedo M, Wang L, Cristina T. Laparoscopic spenectomy in the treatment of childhood hematologic disorders. Br J Videosurg. 2010;3(4):195-9.
42. Zhu J, Ye H, Wang Y, Zhao T, Zhu Y, Xie Z, et al. Laparoscopic versus open pediatric splenectomy for massive splenomegaly. Surg Innov. 2011 Dec;18(4):349-53.
43. Baiji Yahui Liu, Ping Zhang, Yingchao Wang, Guangyi Wang. A Two-step control of secondary splenic predicles using Ligasure during laparoscopic splenectomy. Int J Med Sci. 2012;9:744-7.

44. Ferndale L, Naidoo M, Bhaila SH, Thomson. Initial experience with laparoscopic splenectomy for immune thrombocytopenic purpura. S Afr J Surg. 2013;51(2):54-6.
45. Wu Z, Zhou J, Wang X, Li YB. Laparoscopic Splenectomy for treatment of splenic marginal zone lymphoma. World J Gastroenterol. 2013 Jun;19(24):3584-660.
46. Ucmak H, Buyukbese SS, Buyukbese MA, Kus S. Laparoscopic splenectomy and infection. J Microbiol Infect Dis. 2013;3(1):1-2.
47. Joshi M, Kurhade S, Peethambaram MS. Single - incision laparoscopic splenectomy. JAMS. 2011;7:65-7.
48. Pedziwatr M, Matlok M, Major P, Kulis D, Budzynski A. Laparoscopic surgery of the spleen through single umbilical incision. Videosurg. Miniinv. 2013;(1):8-12.
49. Katkhouda N, Hurwitz MB, Rivera RT, Chandra M, Waldrep DJ, Gugenheim J, et al. Laparoscopic splenectomy: outcome and efficacy in 103 consecutive patients. Ann Surg. 1998 Oct;228(4):568-78.
50. Romano F, Caprotti R, Franciosi C, Finna SD, Colombo G, Uggeri F. Laparoscopic splenectomy using LigaSure. Preliminary experience. Surg Endosc. 2002;16(11):1608-11.
51. Kwon HC, Moon CH. Cho YR. Prognostic factors of response to laparoscopic, splenectomy in patients with idiopathic thrombocytopenic purpura. J Korean Med Sci. 2005;20:417-20.
52. Sapucahy MV, Faintuch J, Bresciani CJ. Laparoscopic versus open splenectomy in the management of hemotologic diseases. S. Paulo. 2003;58(5):243-9.
53. Beli RL, Reinhardt KE, Cho E, Flowers, JL. A ten-year single institution experience with laparoscopic splenectomy. J Soc Laparoendosc Surg (JSLS). 2005;9:163-8.
54. Silecchia G, Boru CE, Fantini A. Laparoscopic splenectomy in the management of benign and malignant hematologic diseases. J Soc Laparoendosc Surg (JSLS). 2006;10:199-205.

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