GUIDELINES

Guidelines for Laparoscopic Splenectomy

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SUMMARY

Guidelines are the key points in the management of many health issues in high-standard medical centers around the world typically based on the evidence-based standards by the teamwork panels of these guidelines. The practical guidelines for laparoscopic splenectomy (LS) as a precise study in this field within the literature and surgical text books are the main objective of this research. It is believed that this Clinical Practice Guidance for LS could be feasible and fulfilsome aspects of L Sutilized by physicians, health care workers and patients. Following the grading system developed by CEBM[1], the standard of evidence (LoE) is as follows:
I- Randomized Controlled Trials (RCTs, LoE 1)
II- Non-randomized controlled clinical trials (CCTs, LoE 2)
III- Case series with non-concurrent (i.e., historical) control groups (LoE 3)
IV- Simple case series (LoE 4)
The Grade of Recommendation (GoR) for each consensus statement followed the quality of scientific evidence as follows:

1. A (high quality evidence as RCTs with constantoutcomes and positive risk-benefit proportion).
2. B (moderate quality evidence as CCTs or inconsistent outcomes of high quality researches),
3. C (low quality evidence as case series or inconsistent outcomes of high quality researches with proper clinical practices in the cases of lacking or low quality evidence).

Recommendations: The core guidelines are outlined in thirty recommendations as follows:

Laparoscopic Versus Open Splenectomy

Recommendation 1: In many indications, laparoscopic approach is better than open surgery (OS)since it decrease thedifficulty of operation and lessrecovery (GoR B). Considering all diseases needingsplenectomy (*S*), a common notion highlights the laparoscopic process to open technique. Accordingly, LS is seemedas a traditional solution for many symptoms, however, there are few confinements for patients with extreme medical comorbiditys, splenomegaly and plenic trauma.LS could take longer operation time than OS. It is noted that there are no vivid variations between LS and OS in terms of operation timefor normal- sized or moderately enlarged spleens in literature. Also, it is reported that operation time directly relatesto spleen size, then spleens with more than 27 cm long shows100 conversion rate. Many studies believe that intra-operative blood loss is low with LS. Regardless of strategy, the incidence of intra-operative difficulties tends to be identical. Post-splenectomy complexeswith pulmonary complicationsas pneumonia, atelectasis, intra-abdominal and wound infections with less LS ratio was recorded. Undetected accessory spleens could be the reason of recurrence of diseases, particularly in autoimmune hematologic diseases. Some studies believe that LS brings the danger of missing accessory spleens, however, defining the ratio compared to those in open surgery was also reported.After LS, the recovery duration is faster (LoE 3b) andthe use of post-operative analgesicsis lower. Better cosmetic could be seen via LS. Counting the platelet after surgery for idiopathic thrombocytopenic purpura (ITP) could be the high symptom to select*S*. There is no significant differential between OS and LS throughout the literature (LoE 3b). Accordingly, it was accepted that LS could be an innovative and safe laparoscopic method for expert surgeons. The other expenses, such as ambulance, operation room and social costs are considered within the surgery expenses. Considering the lower overall hospital expenses of LS (LoE 3b), OScould bring high costs in terms of operation room, technical equipment, relative longer operation times and the use of disposable products. As a result, the overall hospital charges could be less with LS (LoE 3b) benign and Malignant Conditions Splenectomy because of lower hospitalizing.

Recommendation 2: LS is also suggested for malignant and benign diseases (GoR B) because surgery can bring high complications in cases of splenomegaly that require more experience (GoR B). The indications of LS and OS are identical. *S*might be appliedforpreventing the increased corpuscular elements of blood removing and for alleviating thesignsmade by an enlarged spleen comprising early satiety or discomfort and fullness, abdominal distension, in malignant diseases for staging purposes or other diagnostic techniques. ITP is a widely observed sign and the surgeryreason in 50%– 80% of patients treated with LS in cases of benign hematologic diseases. LScould be used for refractory symptomatic thrombocytopenia casesthat follow a medical therapy while there is a need for the remission of toxic steroid doses or for relapsingthe thrombocytopenic purpura following initial steroid therapy response. ITP patients have slightly swollen or normal-sized spleens that bring the benefits of minimally invasive surgery for them.According to literature,*S* is safe (LoE 2b) with greatsuccess in total or partial remission. Considering the high ratio of full remission with no side effects associated to medical therapy, the outcomes are better than those for medical care (LoE 3b). *S*is also appliedfor treatment of other thrombocytopenic purpura forms, such as thrombotic or HIV,LoE 4). *Sc*omprised the inherited spherocytosis, high or moderate thalassemia with secondary hypersplenia or extreme anemia and refractory

autoimmune hemolytic anemia (indicated for hemolytic anemia).

Recommendation 3: During LS, there is a recommendation of regular checking for accessory splenic tissue for autoimmune hematologic disorders (autoimmune hemolytic anemia and autoimmune thrombocytopenia) to prevent and recurrence of disease (GoR C). Controlled Trials correctly estimates the position and number of accessory spleens (with 100% accuracy) (LoE 3b) compared to intraoperative results. Regarding the high resolution of CT, the outcomes of pre-operative localization researches have been essentially advanced. Despite the accessory spleen size, the current detection ratio of preoperative spiral CT is full (100%).Thus, there is a compulsory accessory spleens check along the LS surgery while its results are compared to OS. A maximal detection ratio can be obtained while combining the checking results with preoperative imaging. During the initial surgery, a handheld gamma probe for an intraoperative accessory spleens detection has been lately applied while its finding has been compared to theintraoperative and preoperative CT ones (LoE 4) that showed 100% accuracy. However, a full detection of splenic tissue is essential during the surgery.

Recommendation 4: LS is proposed for malignant hematologic diseases that needs*S* (GoR B). Despite the complexity of treatment, it could be possible if treated technically in major splenomegaly (GoR C).Hand-assisted LS (HALS) port or an extraoccurrencecould beapplied for specimen retrieval if the spleen is to be fully extracted for histopathologicaltest or if tumor spillage isinevitable (GoR C).Hematologic malignanciesas myeloproliferative disorders (i.e. myelofibrosis), lymphoproliferative disorders including autoimmune thrombocytopenia or autoimmune hemolytic anemia, hairy cell leukemia, chronic lymphocytic leukemia with massive splenomegaly and splenic lymphoma - need *S* for therapeutic or diagnostic purposes (LoE 4). Removing of intact organ might be proper for pathological testfor staging and diagnosis in cases of *S* through an incision (8 to 10 cm) or might remove spleenthrough HALS with no incision.So rare cases of primary splenic origin (malignancies) including lymphangiosarcomas, malignant vascular tumors as hemangiosarcoma or malignant lymphoma are seen.Majority of splenic cancers metastasize asovarian cancer or malignant melanoma. In order to histopathological examining, the spleen is pieced (roughly 3 cm) accurately to prevent port-site metastasis and tumor spillage (LoE 3b).It is compulsory to position the spleen in a thick bag for morcellation or retrieval.

Recommendation 5: Laparoscopy is a safe technique for removing the accessory spleens or splenosis (GoR C). Initial disease recurrence might be because of the residual splenic tissue especially in ITP like the accessory spleen missing along the primaryoperatio or splenic implants formed in surgery as splenosis after the damage of cell spillage and splenic capsule. Laparoscopy is a safe removal method in case of finding a residual splenic tissue (LoE 4).

Recommendation 6: Though laparoscopy (pioneered 1994) is applicable for partial *S*, it is not recommended for adults (GoR C). Due to the life threatening of early and late *S* complications as portal or splenic vein thrombosis or overwhelming post-splenectomy infection, spleen-sparing strategies have been developed. Benign tumors,single metastasis, nonparasitic cysts and splenomegaly of unknown origin are the symptoms. Despite the diagnostic assessments of focal splenic lesions by MRI[2], the preoperative distinction is still complicate. Spleen resection methodincludes the corresponding vessels' sealing with ultrasonic shears or LigaSureTM, Valleylab (Boulder, CO) and then using gradual and atraumaticcompression with a grasper to parenchyma without breaking the capsule. The spleen portion was resected through an endostapler, later the raw edge was sealed by use of collagen fleece and fibrin.

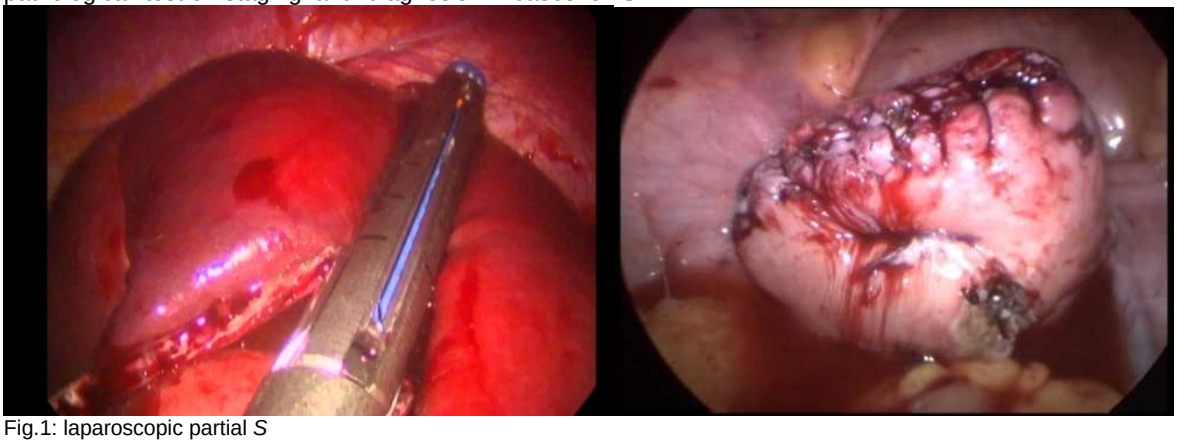


Fig.1: laparoscopic partial *S*

Recommendation 7: Laparoscopic care is proposed for adults (GoR C) in case of any splenic cyst surgery whether parasitic or nonparasitic origin. Splenic cyst is divided to two sub groups (primary and secondary) based on the fact that the cyst wall has an epithelial lining or not (i.e. pseudocyst).Nonparasitic splenic cysts (covering roughly spleen lesions ranged 50-80%) are often pseudocystsbecause of pre-abdominal trauma. Primary nonparasitic cysts are congenital. Nonparasitic cysts surgical is applied for the cysts bigger than 5cm in adults, adding that any complex cysts need to be treated with spleen-preserving resection i.e., cystectomy, partial *S* or

cyst decapsulation.Shas been routinely applied for splenic cysts treatment, also spleen-conserving processing is encouraged. It is noted that these processing could bring the cyst recurrence risk, particularly in cases of epithelial lining primary cysts.

Recommendation 8: Based on the surrounding inflammation degree with fibrous attachments and vascular adhesions, LS is applicable, but more challenging for splenic abscess from the theatric point of view. Despite the lack of evidences, laparoscopic technique is known as a safe and successful process.

Aneurysms in splenic arteries: Common visceral artery aneurysms with the frequency of 0.04% - 0.1% is raised for the patients with portal hypertension and cirrhosis (up to 20%). Most aneurysms are found in a bifurcation in the middle or distal section of splenic artery and in multiple aneurysms (20%).

Recommendation 9: If aneurysms become symptomatic as back pain or abdominal pain, before liver transplantation, in the presence of portal hypertension and pseudoaneurysms of any duration, in pregnant women or if it is bigger than 2 or 2.5 cm, more care is significant. Asymptomatic aneurysms treatment is also essential with the potential of being enlargement. Spleen-preserving measurements as endovascular splenic arterial therapies may be used in most cases of splenic arterial aneurysms. Whilst, surgery by partial *S* (in case of no choice) or laparoscopic exclusion of aneurysm could be the case.

LS

Splenomegaly can be defined by preoperative imaging in metric terms e.g. defining a maximal splenic bigger than 15 cm (No GoR). A splenic bigger than 20 cm need major splenomegaly (No GoR).

Fig.2: Splenomegaly

The managing of splenomegaly is contentious. While splenomegaly is contradicted somehow with LS, someresearchesdefined the laparoscopic management feasible for any spleen size (LoE 3b). A healthy spleen is roughly 11 × 7 × 4 cm with 100 to 250 g weight (wet spleen weight) in adults. 'Splenomegaly" or “huge splenomegaly” has not been presented in previous studies, however, “giant” and “supermassive” have been applied. In this case, splenomegaly could bemorethan 15 cm long axis and massive splenomegaly could be more than 20 cm long axis. There is no measurement for the weight because it is defined prior to the surgery, but the accurate data is gained by ultrasonic. Computed tomography could be used, despite its high cost and less benefits for defining the splenic size. On the other hand, MRI, because of its high cost and low provisions in some countries, couldn’t also be an effective technique in pathologic spleen conditions and determining its size.

Recommendation 10: For the HALS splenomegaly treatment (not massive splenomegaly),LS is more secure and applicable to open surgery (GoR B). Considering the LS in splenomegaly researches, LS takes more operation time, complications of operation, long hospitalizing, anemia and more conversion ratios (LoE 2b) than LS in normal sized spleens. Overall, LS is more preferable to open *S*.

Recommendation 11: In the case of massive splenomegaly (bigger than 20 cm),open *S* (GoR C) or hand-assisted laparoscopic should be highly regarded, because bigger spleen needs a relative open surgery. Regarding the small abdominal working space, difficulty of intra-abdominal operation and retrieval of large organ, laparoscopic resection is challenging inmassive splenomegaly case. It was reported that while performing solely laparoscopic method,spleens more than 27 cm (LoE 3b) or 30 cm need a conversion to open *S* and HALS. Also, HALS was recommended for the spleens with excessive 19 cm width and 22 or 23 cm length. By the raise of splenic weight and size, complexity and time of operation, conversion ratio and blood losing become more as well. Worse surgical outcomes have been reported for the spleens more than 500 g (LoE 3b) or 1000 g (LoE 3b).

HLAS

Recommendation 12: A valid approach to HALS is (GoR B), also for avoiding from OS, GoR B is recommended. HALS is also benefit for massive splenomegaly as the initial treatment since it reduces both the operation duration and intraoperative blood lossing (GoR B).

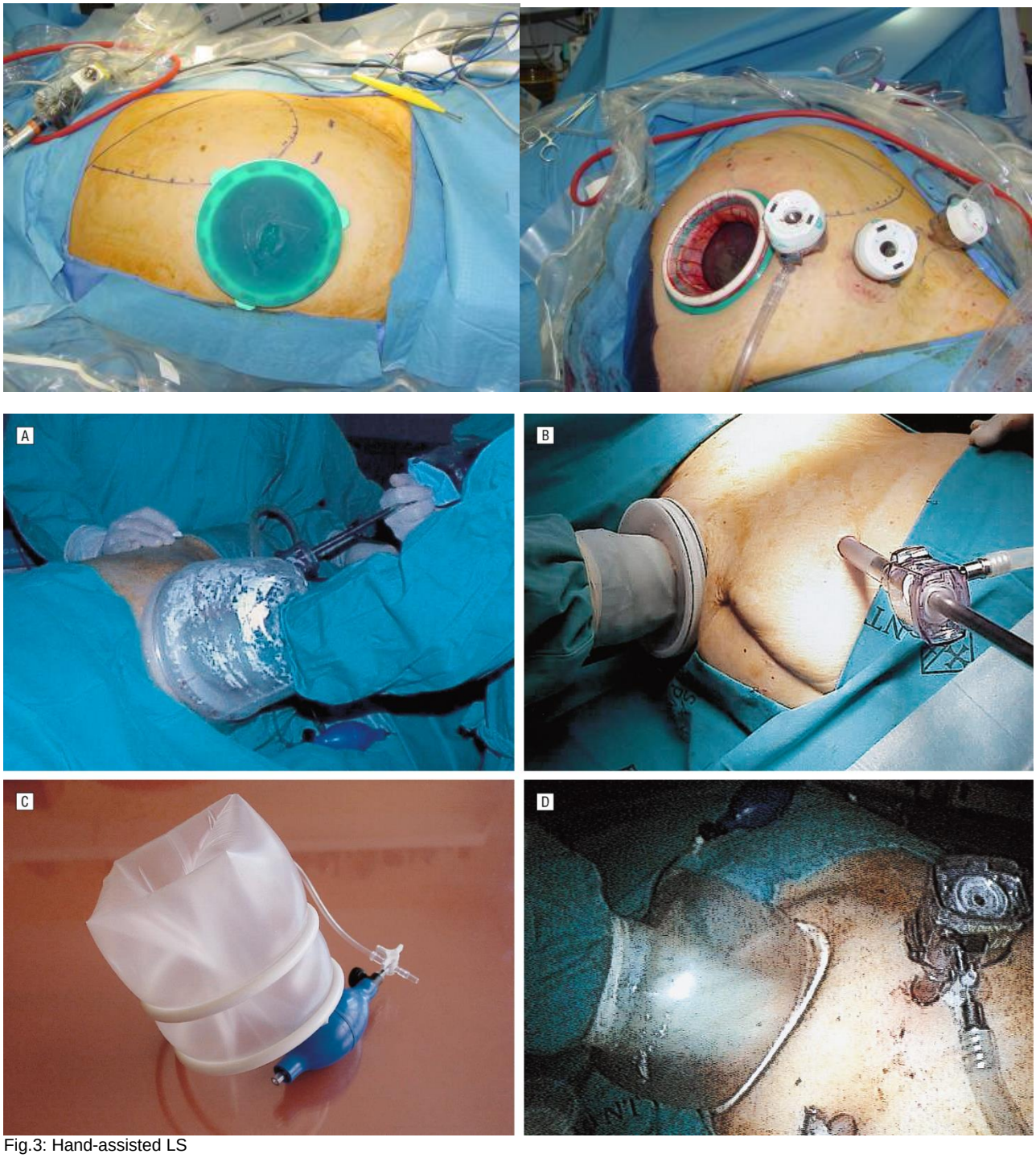


Fig.3: Hand-assisted LS

An alternative to LS is HALS. For this purpose, patient is located in a semi lateral or 45° right lateral decubitus position on operation table while making an incision (7-8cm) in the upper right abdomen or upper midline (or at the location of McBurney or Pfannenstiel) to let the forearm enter the incision. The incision position is changed based on the spleen size to allow the surgeon for inserting the non-dominant hand in the incision while retaining pneumoperitoneum. While putting one hand within extraincision and tightening the skin around the wrist with a towel clamp, the process was continued without the hand port unit.The inserted hand makesthe tactile input and can aid the surgery along the retraction, dissectionand positioning of enlarged spleen into the retrieval bag. On the other hand, managing the unforeseen conditions as haemorrhages or adhesions is essential. Through an extra incision, the spleen could be removed often without morcellation. In less operation times, it was studied that

HALS has lower conversion ratio and lower perioperative complications (i.e. hilary structure or parenchymal bleeding) in cases of splenomegaly than in strictly laparoscopic methods (LoE 3b). Existence of extra incision could damage the abdominal wall, then HALS bringmore benefits than thetraditional laparoscopic surgery i.e. short hospitalizing, early oral diet and less post-operative pain comparingwith OSS (LoE 3b).For any spleen with 22 cm length (LoE 3b), HALS was recommended, but not for normal-sized spleens (LoE 4]).

Boundaries of the laparoscopic method

Recommendation 13: Portal hepatic cirrhosis hypertension should still be opposed with LSS (GoR C), also portal gastric varicose hypertension raises the intraoperative haemorrhage risks (LoE 4).

Recommendation 14: Morbid obesity is not opposed with LSin the presence ofraised laparoscopic surgery for morbid obesity (BMI[3]>35) (GoR C), so it is more preferable (GoR C). Morbid obesity patientscould have complications along the operation because of the confined operation space and less visualized space making increased blood loss, but not more differential in BMI-related operation time, hospitalizing and difficulty ratio. Since obese patients benefit from the lower complication ratios like wound infection related with the laparoscopic method (LoE 3b), its usage is approved. In patients with BMI > 40, operationtime is longer, beside the high conversion ratio and high difficulty.

Recommendation 15: Patient's age couldn't be opposed with LS (GoR B) in the absence of severe comorbidities, however, surgery progress depends heavily on the co-existing of clinical features received low score from ASA[4] (e.g. cardiovascular diseases) (LoE 2b).

Recommendation 16: Despite the satisfactory reports of LS over pregnant women, surgery delay normally is advised during pregnancy (GoR C). There is a rare need for immediate *S* during pregnancy and the signs including hemolytic crisis in hereditary spherocytosis as (LoE 4). Due to the low relative of foetal death, the second trimester of pregnancy could be taken for surgery. In addition, the gravid uterus is not reached a size making technical problems such as damaged working space in intra-abdominal region.Hasson technique is initially recommended for forming pneumoperitoneum and followed by using laparoscope.

Preoperative imagery

Recommendation 17: All adults scheduled for *S*need to be assessed pre-operatively by ultrasound (GoR B) to define the spleen size and volume. For the better diagnosis of the existence of accessory spleens, anatomy or anysuspected malignancy, thin-slice spiral CT is needed (GoR C).Ultrasonography is effectively used to assess the anatomical features as vascular disorders,spleen size and concomitant diseases in patients with benign hematologic diseases (e.g. gallstones). Thin-slice spiral CT by providing accurate splenic size and volume can be applied to diagnosethe accessory spleens in patients with hemolytic or autoimmune disordersas well as perisplenic inflammation, splenic infarction and potential splenic hilum lymphadenopathy that might raise serious intraoperative complications.

Preoperative leadership

Recommendation 18: For autoimmune thrombocytopenia, treatment with preoperative steroid and/or immunoglobulin administration and likely intraoperative platelet transfusion should be used in therapy-resistant patients if the platelet count is lower than 20 × 109/l (GoR C). Though LS does not exclude a platelet count less than 20 × 109/lpatients with lessplatelet have greater complication risk (GoR C). Haematologist finds a preoperative platelet count more than 50 × 109/l as relevant, adding that less platelet counts brings serious intraoperative bleeding risks. Thus, the prescription of Prednisone (1 mg/day) starting 5 - 7 days before surgery has been performed to gain the preoperative counts more than 50 × 109/l. However, any failure to achieve this amount of thrombocyte count couldn't make a problem to the operation,since the extended steroid therapy couldn'tindicatebetter outcomes.Morbidity ratiosounds to be associated with the thrombocytopenia level, then especial measuring has to be performed to preoperatively platelet count raising (e.g. through steroid administration) or platelet transfusions in selected cases along the operation after splenic pedicle division(s) (LoE 4).Immunoglobulinsas a successful but expensive option could bring more undesirable side effects. Immunoglobulin G (e.g. 400 mg/kg/day) should be taken at least 1 week beforethe surgery for 3 - 5 days to increase the platelet count averagely 50 or 80 × 109/l. Transfusions of packed erythrocytes to elevate the hemoglobindegrees above 10 g/dl prior to operation are advised in cases of anemia.

Recommendation 19:

Meningococcal, pneumococcal and H vaccine

Form B influenza infections are recommended in selectivepatients (GoR C) for at least 2 weeks prior to operation. A significant longitude danger for splenectomized patients is the risk of an overwhelming post-splenectomy infection as a life-threatening sepsis that was initially caused by contamination with spleen-eliminated encapsulated species. Maximum infection risk occurs within the first 2 years after *S*, however, 1/3 of all infections happen more than 5 years after *S*orwith a risk for all life. When the overall occurrence index is 3.2% (low), the mortality ratio is exceptionally 40-50% (high) in terms of infection. Maximum risk is (LoE 2a) in patients with major thalassemia and sickle cell anemia.

Streptococcus pneumoniae vaccine, H

Neisseria meningitidis infection and type B influenza are offered at least 2 weeksbefore the operation or urgently 1 month post the operation (LoE 4).

Recommendation 20: Prophylaxis (antibiotic) should be used in operation room once before surgery (GoR C), also the patient should be informed from the lifetime infection risk after *S*. Prophylaxis in the form ofcefazolin was injected (or clindamycin) oncepre-operative followed by the intravenous post-operative administration of amoxicillin (or erythromycin). Administration of oral penicillin V prophylaxis (or erythromycin) in adults (for at least 2 years) and in infants (for 5 years) is proposed. Lifelong prophylaxis has been recommended in which patients need to take immediately amoxicillin in any flu symptoms (LoE 4).

Embolization of Splenic Arteries

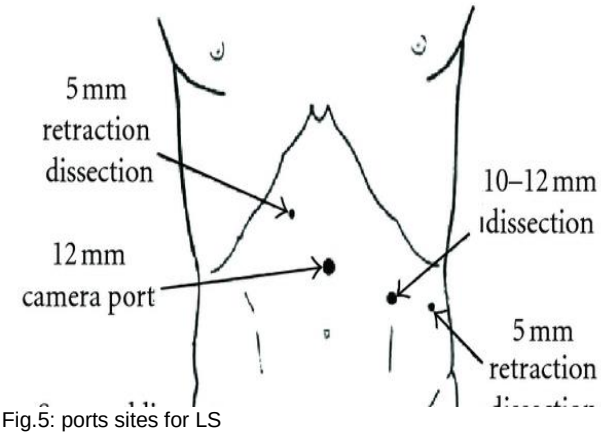
Recommendation 21: Regular pre-operative embolization of splenic artery is not proposedsince it brings more pain and ischemic complications (GoR C).This technique is used

to declinethe splenic size one day before operation.Therefore, improving manoeuvrability and reducing bleeding complications, particularly in large and excessive large spleens are major parameter in OS conversion. It is noted that this process brings extreme pain (for the patient) plus ischemic and embolic complications impacting other organs i.e. pancreatic tail with consecutive pancreatitis that share one similar blood supplying (LoE 4).Other techniques are preoperative embolization of artery through *"painless contour emboli"*once pre-operation or few hours before operation for patients exposed with general anesthesiaduring the surgery (LoE 3b). Preoperative splenic artery embolization is used to prevent the severe intraoperative bleeding in highly swollen spleens (LoE 4).

LS Technical Aspects

Recommendation 22:LScould be done through a lateral, semi-lateral or supine technique following the spleen size, patient's characteristics, surgeon's choice and care requirements (GoR B), say in the beginning of LS years, anterior or *" supine* " position has beenused. This location enables the perfect reaching of omental pouch and the great visualize of splenic hilum. Regarding its close connection to the pancreas tail, problems occur in dissecting and exposing of the ligamental structures plus the splenic hilum and dorsal vessels.In a simultaneous process, the anterior (or supine) position is shown (e.g. cholecystectomy, lymph node biopsies or biopsies of other organs). Later, forreaching to the semi-lateral location, operation tableis rotated to enable *S* process. This position could be done by locating the patient in a semi-lateral position for concomitant process and tilting the operation table to the left of patient so that a supine position is done.Some believes that it is benefitfor massive spleens. The splenic artery can be linked early while reducing the serious bleeding risks (LoE 4).Patient is positionedover the table while the left side is raised by a device (e.g. beanbag, foam wedges) (up to 40 - 45°) with the semilateral method termed "hanging spleen technique" (LoE 4). In this method, the orientation of patient could be tailored to surgical specifications by tilting the table in a way that a total lateral positioning or total supine is achieved. A semi-lateral position for accessing the lower sac and division of narrow gastric vessels at the start of processwas proposed. The operation table might be laterally rotated in a way thatother organs and spleen fall down (gravity). This position eases the accessing of spleen's posterior face and perisplenic ligaments (LoE 3b). Dissection and ligation of splenic hilum vessels are then encouraged while the pancreatic tail is spared.This strategy brings more advantageous since the position of patientcould be altered based on the needs. Hemi-lateral is highly ratified in literature. Patient is put at a 90° angle to the operation table in a full lateral technique. The spleen and viscera fall down (gravity) that allows the ligaments' dissection, providing healthy vascular regulation. Visualization could be in the favor of pancreas' tail, reducing the chance of pancreas damage. In order to fall down the operation time, few trocars are needed, also transfusion needs and hospitalizingwerereported (LoE 3b).

Fig.4: lateralposition for LS



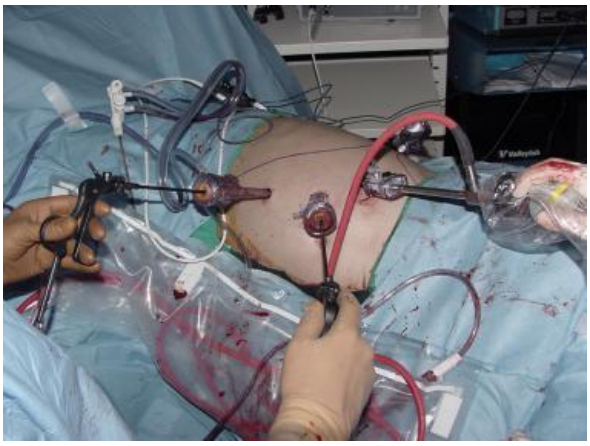


Fig.5: ports sites for LS

Recommendation 23: Advanced bipolar devices, surgical stapling devices and ultrasonic shears all enable LS vascular management proposed to reduce the blood losing and operation time (GoR B). The main difficulty in conversion during LS is bleeding. Considering prior techniques, using endovascular stapler reduce and encourage hilary dissection (LoE 4). Ultrasonic coagulating shears[5] or Electro-thermal bipolar vessel sealers[6]have recently been used to larger hilarious vessels (LoE 4) (LoE4), smaller gastric vessels (LoE 4), tissue includingvessels (LoE 4) and dissect smaller polar vessels.In patients with normal or slightly enlarged spleens

plus the less blood losing, less operation time and lessexpensesare recommended than other methods. So, using LigaSure TM for hilar vessels (up to 7 mm) (LoE 2b) is reported.

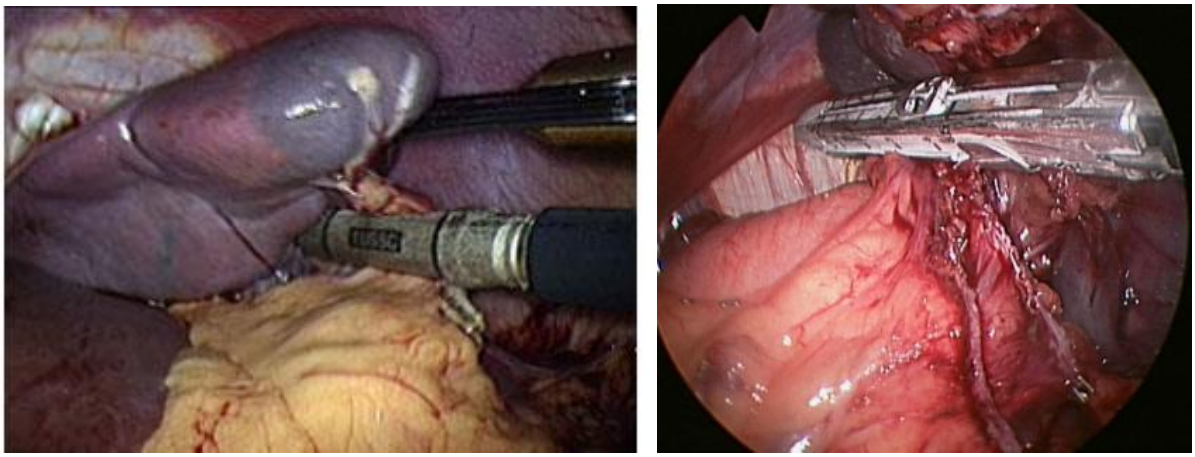


Fig.6. Surgical stapling devices and ultrasonic shears for vascular control

Recommendation 24: To retrieve the intact spleen and/or morcellation, using strong bag is reported to prevent the spillage of splenic tissue (GoR B).

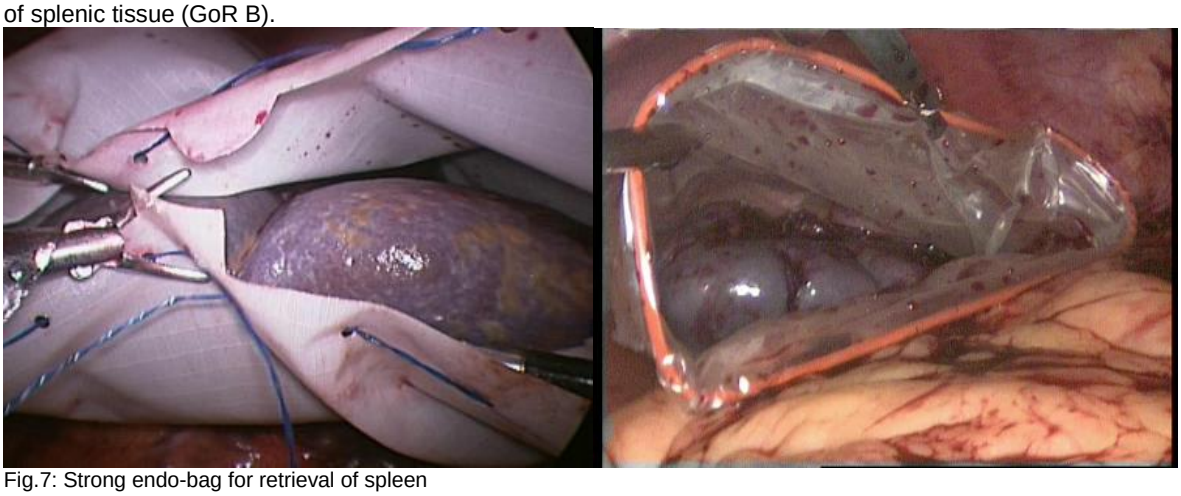


Fig.7: Strong endo-bag for retrieval of spleen

By use of LS, extracting the spleen from the abdomen is a time-consuming operation, particularly in large and excessive large organs that might bring the need for OS or more incision. For removal process, the organ must be morcelled. Meticulous care is needed for preventing the spillage of capsular tears and cells. In malignant and benign diseases, the use of undetected splenic cell might be due to the splenosis and responsible for recurrence. Later, the morcellationprocess need to be donewithin a bag. Tearing of this bag during morcellation has been recorded in literature, therefore, using blunt morcellation tools anda strong bag are recommended (e.g. fingers, ring forceps). Later, extracting the fragments by suction, forceps or both is essential. In ITP, the spleen parts gained after morcellation and piecemeal extraction are adequately adequatefor histopathological analyzing. The spleen should be recovered insingle presentation of lymphoma, splenic malignancy (LoE 4), presumed metastases or staging purposes.

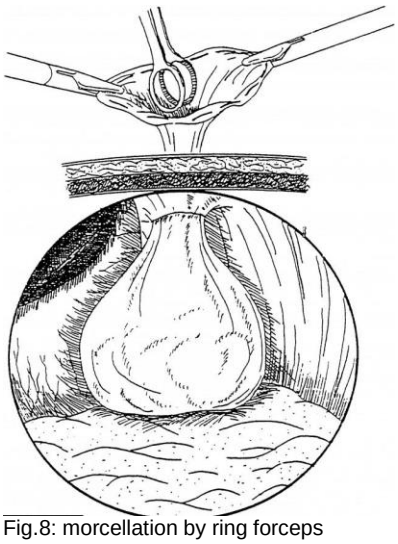


Fig.8: morcellation by ring forceps

Recommendation 25: Regular drainage is not recommended unless particular conditions, say pancreatic injury (GoR C).After *S*, the location of a drain mainly depends on the surgeon' choice (there is no reliable data).

Complications intra- and postoperative

Recommendation 26: In serious bleeding (GoR A), the conversion to OS is low.With autoimmune disorders, gentle spleen stimulation is essentialfor preventing thesplenosis and capsular rupture (GoR C). Intra-operative haemorrhageas a major difficulty might be due to the conversion. That's due to splenic capsule, short gastric vessels, laceration, parenchyma of hilaror enhanced by underlying disease. It is possible for occurring of intraoperative injuries to adjacent organs and structures,particularly pancreatic injury, gastric or diaphragmatic damages. 15% incidence was reported in literature for pancreatic injury defined by peripancreatic fluid collections, amylase-rich drain fluid, pancreatic abscess, isolated hyperamylasemia (minor complication) and atypical postoperative pain. Drain is installed only on any pancreas damage.The risk of developing a major pancreatic complication in patients with splenomegaly was substantially higher mightily attributed to technical defects as multiple staples around the hilum.A regular amylase on postoperative day 1 was recommended to inform the surgeon and adjusting postoperative management (LoE 4).Subphrenic collection or abscess, pneumonia and atelectasis, deep vein thrombosis, postoperative bleeding, pancreatitis, ileus, splenoportal axis thrombosis, abdominal wall hernias, abdominal wall infections and hematomas are some complications after *S*.The frequency occurrence index of these problems after conversion is high (LoE 3b).

Recommendation 27: For all patients, anticoagulant prophylaxis with subcutaneous heparin need to be used before operation for 1 month (high dose) for patients in great denger of portal and splenic vein thrombosis (PSVT) (GoR C).PSVT should be examined and diagnosed early in patients with unknown abdominal signs and could be a threaten for all lifein months. Intestinal infarction and portal hypertension may result. The incidence of PSVT differs from 0.7%- 14%while exceeding 80% among patients with great risk after *S*. The incidence of surgical method (LS or OS) is unknown by now. Though, there was no proof on the influence of surgical procedures on PSVT (LoE 3b) occurrence, other studies showed the significant occurrence index of PSVT following LSVT (LoE 3b).The existence of myeloproliferative disorders relatedtohypercoagulopathy, hematologic malignancy or hypersplenism, hemolytic anemiaand splenomegaly are among the risk parameters to develop PSVT (LoE 3b). Large splenic vein and stump is related to a large organ leadingto thrombi as the origin of thromboembolic occurrences. While PSVT is related to splenic duration, many other factors affect the occurrence of PSVT, such as distal or proximal splenic vein ligation, pneumoperitoneum, early splenic artery ligation and endoscopic vascular stapler usage or haematological changes, such as postoperative platelet count elevation, however, their role in thrombus is unknown. It is noted that symptoms could be ambiguous including nausea, ileus, diarrhoea, diffuse abdominal pain, fever and low appetite. Any diagnosis defects could interrupt few weeks of proper care. Accurate diagnosis could be performed through ultrasonography or CT scan and MRI to detect PSVT. CT scan with intravenous contrast aid the diagnosisof PSVT, alsomight omit other intra-abdominal problems.Immediate anticoagulant treatment with intravenous heparin after diagnosis, oral warfarin therapy at hospital or therapeutic low-molecular-weight heparin doses have decent outcomes (>90% recanalization if immediately treated). Regular thrombolytic administration with Streptokinase or Alteplasecould be an option if rarely administered. The current dose of warfarin administration of 2, 3 and 6 months could maintain an international standardized ratio (INR), while an INR of between 1.5 and 2.0 for approximately 3 months is also proposed.

Long-term LS Result

Recommendation 28: LS could be effectual in long-term resolution of haematological diseases, particularly in hrombocytopenia (GoR B).Whilst, no definite preoperativepredictors of a positive result for*S*has been seen.While a platelet countsmore than 50 × 109/l could be important by some scholars, others believe 150 × 109/l as important. Based on few studies, the longituderesults of OS and LS could be similar (LoE 3b). Based on some surgeon's view, age could play important role in determining the success or failure of the surgery (older or younger than 40 years), as well as platelet count and preoperative response to corticosteroids. Regardless of young ages, a good response to corticosteroids and a short period among the onset of disease and surgery time indicated better remission rates in ITP patients, also the preoperative performance of *S* cannot be predicted.

Special features of children's LS

Recommendation 29: In case of *S*, laparoscopic method should be suggested for infants (GoR B), however,it should be delayed till the 6th age or older (GoR C).The size of spleen and abdominal cavity in children reduce the conversion threshold ratio (GoR C). Like adults, LS could bring the same advantageous to OS for children, such as shorter hospitalizing, high and low blood loss, similar or lower complication rate and better cosmetic for children (LoE 3b). Additionally, less post-operative pains and earlier recovery are important in pediatric patients (LoE 3b). Concentrating over the long-term ITP patients' results, similar to adults, this method is successful with no variations between laparoscopic and open methods (LoE 3b).Hematologic statues as ITP, sickle-cell anemia, hereditary spherocytosis and beta-thalassemiaare reasons for *S* in infants. Regarding therapy-resistant ITP, hereditary spherocytosis is the most common symptom. Considering less ASA score and less blood loss, variation of LS between pediatric patients (age <17 years) and adults has been analyzed.The estimation of splenic scale by pure metric data is not applicable in children,because it is related to the size of body. "Massive" splenomegaly is determined for a spleen four times bigger than the age average.However,based on some data, the conversion ratiocould be align with thesize of splenic. Also, spleens > 500 g are in the risk of OS conversion (LoE 3b). As a result, extra recovery incisions, HALS and preoperative

embolization of splenic artery couldn't be applicable in infants (LoE 4).

Recommendation 30: Children undergoing elective *S* should be vaccinated against *S* including children younger than 2 years of age.

Pneumoniasis, N

Meningitides and H. Form B influenza infection before surgery (GoR B).Post-splenectomy infection most often occurs as a pulmonary infection, and the occurrence index of severe infection is down. In case of serious infection(s), the mortality ratio is great (up to 50%). Re-immunization is also recommended every 5 to 10 years (LoE 3b). in this case, for infant patients (below 5 years),daily penicillin is recommended. Others believe that this prophylactic therapy need to be extended up to 10 years old.

Abbreviation:

laparoscopicsplenectomy (LS)
splenectomy (S)
idiopathic thrombocytopenic purpura (ITP)
Randomized Controlled Trials (RCTs)

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