Int J Clin Exp Med 2019;12(4):4414-4421
www.ijcem.com /ISSN:1940-5901/IJCEM0077569

Case Report

Single-port laparoscopic partial splenectomy for a huge splenic cyst: a case report

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Received April 8, 2018; Accepted December 11, 2018; Epub April 15, 2019; Published April 30, 2019

Abstract: The immunologic function of the spleen and asplenia-related life-threatening complications often lead to a partial splenectomy (PS), which allows both effective removal of lesions and preservation of splenic function. With the continuous development and improvement of laparoscopic techniques, laparoscopic partial splenectomy (LPS) has become a common option for many spleen diseases, such as nonparasitic cysts, benign tumors, and staging of lymphomas. Moreover, many laparoscopic surgeons have attempted to minimize tissue trauma, limit morbidity, and maximize cosmesis by using fewer and smaller ports. This has taken many forms, most notably single-port laparoscopic surgery (SPLS), which minimizes access trauma, as does natural orifice transluminal endoscopic surgery. However, the spread of SPLS for PS has not been as fast as expected. More technical difficulties for the surgeon must be considered. The current study reports a case of a 20-year-old female with a large benign splenic cyst, resolved by single-port laparoscopic partial splenectomy (SPLPS). Surgery lasted 165 minutes without any intraoperative complications. It did not require blood transfusions. The patient left the hospital on the 4th postoperative day after an uneventful recovery. At 1-month follow-up, there were no sequelae or recurrences. This experience suggests that SPLPS is feasible and safe when performed by experienced laparoscopic surgeons. However, randomized trials will be necessary to evaluate the feasibility, safety, and potential benefits of SPLPS.

Keywords: Single-port, laparoscopic partial splenectomy (LPS), splenic cyst

Introduction

Laparoscopic total splenectomy (LTS) has been used for the management of various diseases of the spleen for over 20 years. It is a well-established routine procedure, practiced in many centers [1]. The risk of severe complications of total splenectomy, even via laparoscopy, such as overwhelming post-splenectomy sepsis (OPSS), pulmonary complications, and thromboembolisms, as well as a sharp increase of platelet levels and the awareness of immunologic function of the spleen, have led to a search for splenic-preserving techniques [2]. The partial splenectomy (PS) was developed as a result of these attempts. The first successful PS via laparoscope was reported in 1995 by Poulin et al. [3]. Thereafter, many clinical laparoscopic partial splenectomies (LPS) for different pathologies have been carried out, due to its effectiveness, low-complication rates, patient comfort, shorter hospital stays, and faster recovery [4]. In this context, LPS is preferable to LTS in cases such as nonparasitic cysts, benign tumors, and staging of lymphomas. Due to the aim of inducing less parietal trauma and fewer scars of minimally invasive procedures, single-port laparoscopic surgery (SPLS), gaining popularity, has been introduced with better cosmetic outcomes, less postoperative pain, higher patient satisfaction, and faster recovery than standard laparoscopy [5]. While special trocars and instruments are needed, the spectrum of SPLS clinical indications corresponds to conventional laparoscopic surgery. Although the procedures and feasibility of SPLS in cholecystectomies [6], appendectomies [7], and colectomies [8] have been reported, single-port laparoscopic partial splenectomies (SPLPS) have not been commonly reported in the literature [9]. SPLPS remains a surgical challenge because of the technical difficulties and bleeding risks. The current study reports a case of SPLPS for a benign splenic cyst. This study asserts

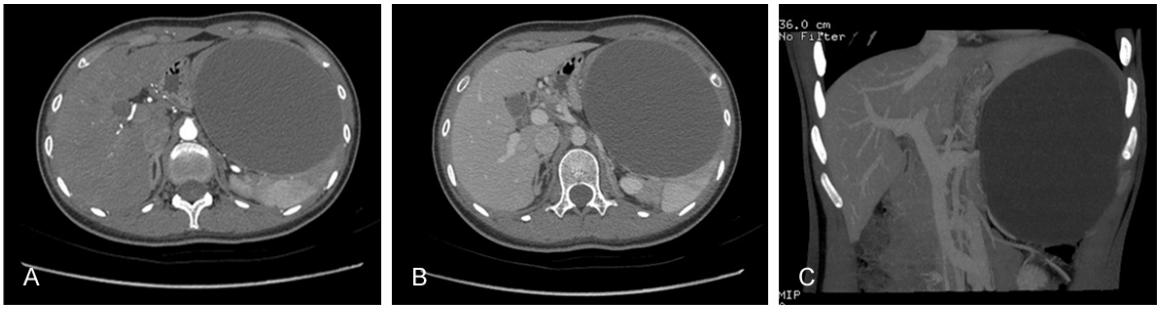

Figure 1. A-C. Preoperative CT showing a huge splenic cyst located in the lower pole segment of the spleen.

that SPLPS can be performed safely, efficiently, and with similar efficacy, compared with the conventional multiple-port laparoscopic approach.

Case report

A 20-year-old female patient was admitted to Xinqiao Hospital, Third Military Medical University (Army Medical University), in May 2017, after finding a mass in her left upper abdomen 2 weeks prior. The patient did not have a previous medical history. The patient's physical examination was not contributory. Abdominal ultrasound revealed a cystic space-occupying lesion in the left upper abdomen, showing unclear boundaries with the spleen. It was considered a splenic cyst. Computed Tomography (CT) revealed a cystic non-enhanced and low-density shadow in the spleen, of approximately 12.6×10.2 cm in size. It was possibly a splenic cyst. The localized splenic vein was small due to compression by the splenic lesion (**Figure 1A-C**). Results of complete blood counts, liver and kidney function tests, coagulation tests, and gastrointestinal tumor markers showed no anomalies. Clinical diagnosis: cystic space-occupying lesion in the spleen. Splenic cysts are a rare condition. It is difficult to know their true incidence. Splenic cysts are classified based on the presence (congenital) or absence (post-traumatic) of epithelial lining [10]. Management of a splenic cyst is controversial. Cystectomies, fenestration, percutaneous drainage and sclerotherapies, and partial or total splenectomies have all been described [11]. Since the cystic lesion was found in the lower pole of the spleen, the possibility of cyst recurrence was extremely high if a cystectomy, fenestration, percutaneous drainage, and sclerotherapy were performed. On the other hand, with a better understanding of the importance of splenic preservation and advances in laparoscopy, LPS has become a common option for many spleen diseases. Moreover, advances in SPLS have allowed the performance of more minimally invasive surgical treatment. Therefore, SPLPS was proposed. The patient was informed about the details of the surgical procedure. She provided informed consent.

For this procedure, an SILS port (Covidien, Norwalk, Connecticut, USA), a 5-mm laparoscope (Karl Storz, Tuttlingen, Germany), an ordinary laparoscopic operation instrument, a flexible laparoscopic operation instrument, a harmonic scalpel (Ethicon Endo-Surgery, Inc., Cincinnati, OH, USA), Hem-o-lok clips (Teleflex Medical RTP, NC, United States), and argon plasma coagulation (Erbe Elektromedizin, Tuebingen, Germany) were used.

The patient underwent general anesthesia and endotracheal intubation. She was placed in the supine position and the left lumbar spine was lifted with a pad by approximately 10 cm. To gain better access and exposure, the operating table was adjusted during surgery, tilted to the right to elevate the left side. The surgeon stood on the right side of the patient. The assistant and monitor were on the left side of the patient, facing the surgeon. To prevent gastroenteric turgor, a gastric tube was placed during surgery. It was removed after surgery. To prevent urinary retention, catheterization was performed after successful anesthetic induction. The catheter was removed after the surgery was complete and before the patient awoke from anesthesia. A trans-umbilical longitudinal incision was created on the skin and the subcutaneous tissue. After establishment of the pneumoperitoneum, at a pressure of 14 mmHg

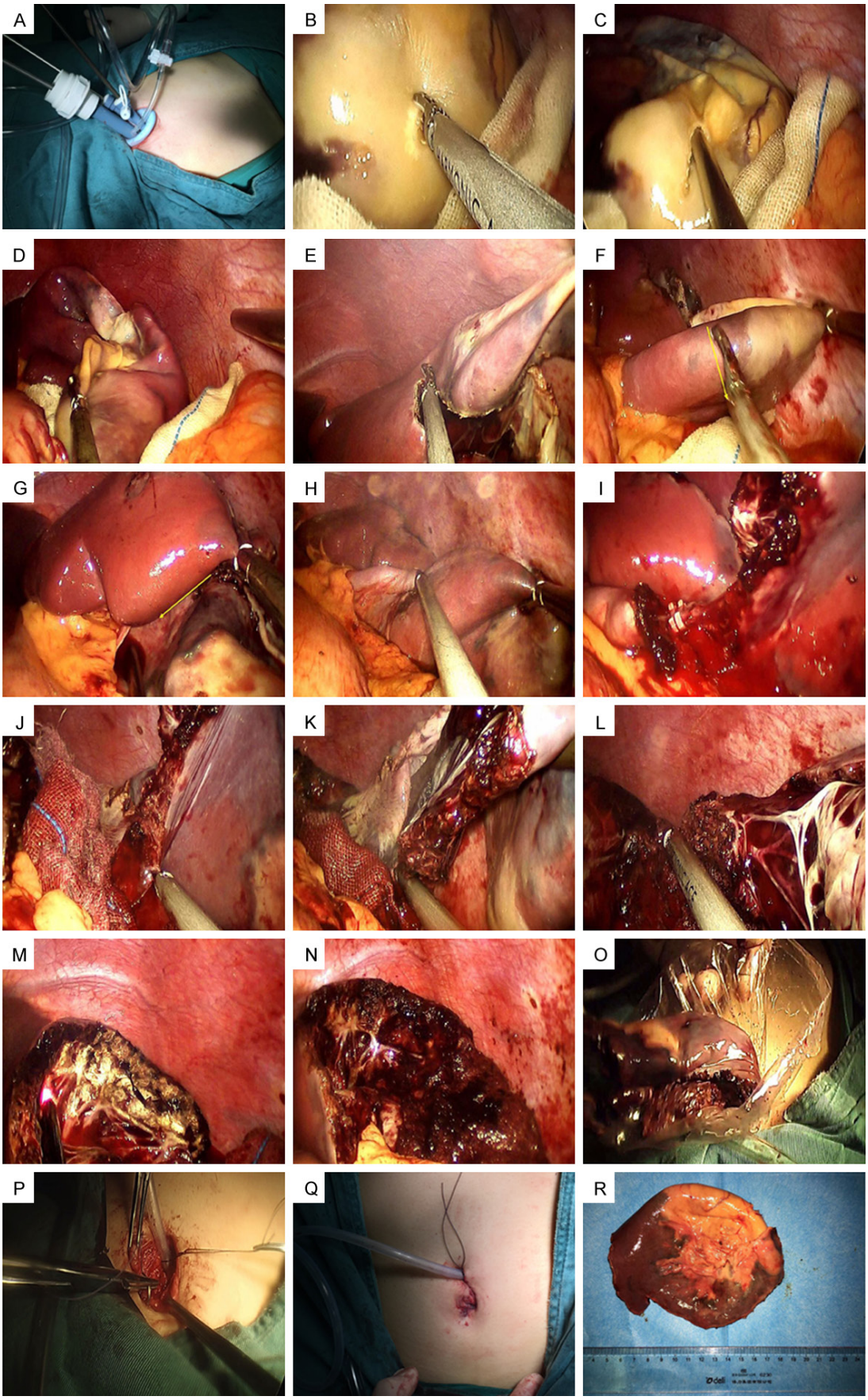
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Figure 2. Laparoscopic technique and procedure. (A) The SILS port was inserted into the umbilical incision with all instruments. (B-D) Evacuation of splenic cyst. (E-M) The splenic cyst and part of normal spleen was resected by a harmonic scalpel. The yellow arrow in (F and G) represent the direction of splenic parenchymal transection. (N) Photograph showing the cut surface of the spleen. No active bleeding in the wound after the resection. (O) Specimen delivered out using endobag. (P, Q) Umbilical dimple incision was sutured and a drain was inserted through the single umbilical incision toward the splenic recess. A suture was beforehand reserved surrounding the drainage tube for aiding in the closure of the hole at the umbilicus when the intra-abdominal drainage tube was removed. (R) Operative specimen of SPLPS showing an epidermoid splenic cyst and partial resection of the splenic parenchyma.

using a Veress needle, the Covidien SILS port was inserted. The 12-mm channel was used as the main operation port. A 5-mm channel served as the observation port and a pair of bending non-traumatic grasping forceps, designed for a single-port laparoscope, was inserted through the other 5-mm channel. A round cystic mass with a diameter of approximately 15 cm was observed in the lower pole of the spleen, protruding to the surface of the spleen. Intraoperative diagnosis was consistent with the preoperative diagnosis. Considering that the splenic cyst was found in the lower pole of the spleen, reflecting appropriate conditions for partial resection, SPLPS was performed. Because the cyst was large and difficult to expose, the surface of the cyst was first opened using a harmonic scalpel. Approximately 1000 mL of yellowish cyst fluid was suctioned using an aspirator, leading to a collapse of the cyst. A harmonic scalpel was used to mobilize the resecting part of spleen. Due to the difficulty of exposure with a single port, branches of the splenic artery and vein that supply the lower portion of the spleen were not pre-treated. The splenic cyst was gradually excised together with part of the splenic parenchyma using a harmonic scalpel. In this process, the vessel at the splenic lower pole was gradually exposed and truncated after double ligation with Hem-o-lok. After complete resection, the cystic wall and wound were cauterized via argon plasma coagulation. The removed part of the spleen, containing the huge cyst, was placed into a collection bag. It was carefully removed from the umbilical incision. Wound hemostasis was performed carefully and an abdominal drainage tube was inserted for drainage from the umbilical incision. The umbilical dimple incision was finally sutured. A suture was beforehand reserved surrounding the drainage tube. It could be tensed to close the hole at the umbilicus when the intra-abdominal drainage tube was pulled out. The operation time was 165 min and intraoperative blood loss was approximately 350 mL (**Figure 2A-R**).

The patient recovered well after surgery. On postoperative day 1, she was able to get out of bed and consume a liquid diet, exhibiting no fever or pancreatic fistula. The abdominal drainage tube was removed and the suture was tightened at 36 hours after surgery. Postoperative examination revealed that platelet levels were in the normal range. No anticoagulant drugs were used. On postoperative day 4, the patient was discharged. Pathological examination of the specimen revealed a splenic cyst. At the 7th day follow-up visit, CT scans showed that the remnant upper pole of the spleen was normal (**Figure 3**). The outpatient follow-up examination 30 days later showed normal platelet levels, no splenic infarction on abdominal ultrasound, smooth splenic arteriovenous blood flow without thrombosis, and a well-healed umbilical incision, with no obvious surgical scars and good cosmetic results (**Figure 4**).

This study preliminarily analyzed the clinical outcomes of the SPLPS group and multiport LPS group. There were no significant differences between the groups in terms of operative times, intraoperative blood loss, and postoperative complications. However, postoperative hospital stays in the single-port group were shorter than the multiport group and patients in the single-port group gained a better quality of life (data not shown). Although there were limitations regarding preliminary analysis, such as a small number of patients, result suggest that SPLPS is safe and effective for patients. However, future large randomized studies and well-designed follow-ups are necessary to confirm present findings.

Discussion

Total splenectomy has historically been considered the classic approach for treatment of splenic space-occupying lesions. However, increased awareness of the importance of the spleen, as a primary organ of the human immune system and potential asplenia-related life-threatening complications, has led to de-

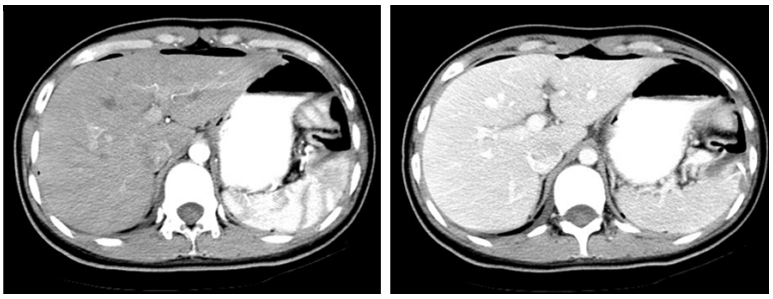

Figure 3. A postoperative CT scan, done at the 1-week follow-up, showing that the residual spleen after SPLPS had good blood supply.

Figure 4. Photograph showing the postoperative umbilical skin wound (postoperative day 30 days).

velopment of a splenic tissue-saving techniques [12]. With recent improvements in the understanding of the vascular structure of the spleen, some surgeons have reported PS to be a safe and feasible approach [13]. Although autologous splenic tissue transplantation is an option for preservation of the function of spleen, it is inferior to PS in terms of regeneration, blood flow, reticuloendothelial clearance, and immunologic function. The objective of PS is to preserve the immunologic function of the spleen via complete removal of the pathologic lesion, coupled with attempts to resolve severe complications after splenectomies. Growing evidence suggests that one quarter of the size of a normal-sized age-adjusted spleen must be retained to fulfil this immunologic function, with the prerequisite of adequate arterial blood supply. PS is a technically demanding procedure. It has been mostly performed by the open approach. However, it has been associated with severe bodily pain and cosmetic disadvantages [14, 15]. It should be noted that the laparoscopic approach to splenectomy is now recognized as the gold standard for most total splenectomy procedures. However, since the first case of LPS was performed by Poulin in 1995 [3], LPS has not been widely performed. This may be due to the technical difficulties and bleeding risks. With the development of fine laparoscopic skills and instruments, several studies have indicated that LPS shows lower morbidity and equal therapeutic efficacy, compared with laparotomic PS, suggesting that it and can be widely performed [16]. Current efforts of minimal access surgery are to reduce even more of the surgical trauma of minimally invasive procedures. SPLS is the result of the constant pursuit of surgeons, aiming to further reduce parietal trauma and to improve cosmetic outcomes. Based on long-term experience with laparoscopic splenectomies and the single-port laparoscopic technique, the present surgery team performed an SPLPS. The operation was successful and the patient recovered well, confirming the feasibility of this technique.

In SPLPS, because device placement is fixed, it is difficult to create the surgical field. Additionally, the operative field is limited and equipment interference can affect the operation. Therefore, the selection of an appropriate position and flexible instruments are conducive to exposure of the hilar of the spleen, thus reducing the difficulty of the operation. Options for positioning mainly include the semi-right lateral position, complete right lateral position, and supine position, with the lumbar spine elevated using a pad [17]. The supine position was used in this study, with the left lumbar spine elevated by approximately 10 cm using a pad. The operating table was adjusted during surgery, tilted to the right to elevate the left side. Comprehensively, regardless of the position used, facilitation of intraoperative exposure of the hilar of the spleen is essential.

Currently, SPLPS can be performed using a transumbilical approach, a left mid-clavicular line approach at the umbilical level, and a hybrid transumbilical approach. The transumbilical approach is not suitable for obese patients with a large spleen, as manipulation of

the upper splenic pole can be extremely difficult in this population. However, this approach results in concealed surgical scars with good cosmetic outcomes. It is more consistent with the "no scar" concept on the abdominal wall. Although the left mid-clavicular line approach at the umbilical level is consistent with the concept of SPLS, allows easy manipulation of the upper pole of the spleen, and reduces the transfer rate, the incision is made in the left upper abdomen, resulting in obvious scarring in the abdomen after surgery. It produces a fairly poor cosmetic outcome. For the hybrid transumbilical approach, a 25-mm arc incision is created at the lower umbilical edge for insertion of the observation port and the main operative port. An additional incision for a 5-mm auxiliary port is created 2 cm below the left subcostal margin to facilitate intraoperative exposure or to serve as an observation port [18-20]. Regarding the selection of access devices, the commercially available SILS port can be used. In addition, some researchers have used incision protection kits and sterile gloves to create a single-port laparoscopic device, resulting in successful surgical outcomes [9, 20].

Preoperative images must be used during surgical planning to determine the volume of the preserved spleen, according to the spleen index or imaging volume system. Verification of the splenic volume during surgery is necessary to maximize the volume of preserved spleen. The most important and difficult steps for splenectomies include mobilization and ligation of the splenic vessels at the splenic pedicle. Increased attention should be given to SPLPS. The segmental blood supply of the spleen is the anatomical basis for SPLPS. Important steps for a successful SPLPS include dissection of the splenic branch arteries at the splenic pedicle from the periphery of the spleen and occlusion or ligation of the corresponding arteries at the hilar of the spleen. In most cases, the splenic artery branches into two or three arteries to supply corresponding splenic segments. In some cases, the spleen may contain seven segments, due to variation of the splenic artery. It is recommended that preoperative routine CT angiographies of the spleen are performed to reveal the anatomical types and paths of the splenic artery and its branches, revealing the relationship between the splenic artery and the pancreatic tail, creating a personalized regimen. Complete "vascular skeletonization" is not required while mobilizing the splenic artery from the spleen pedicle. Instead, gentle manipulation is necessary to avoid a rupture of the splenic artery and vein, which may lead to massive bleeding during surgery. Minor bleeding may originate from splenic vein reflux in some cases. It can be identified by local compression and suction and controlled by clipping or suturing. If the bleeding is uncontrolled, conversion to open surgery is necessary [13, 21]. During regular SPLPS, after mobilization of the splenic artery branches, selective branch occlusion produces an ischemic demarcation line, along which the partial spleen parenchyma can be excised. Hong et al. adopted this surgical approach of SPLPS, finding less intraoperative blood loss and demonstrating satisfactory efficacy of the technique. Using this approach, the blood loss is negligible, especially when using laparoscopic hemostatic instruments, such as a harmonic scalpel, LigaSure device, and radiofrequency coagulation device [9, 22]. During irregular SPLPS, blood loss is considerable due to the segmental blood supply of the open splenic artery or incomplete occlusion of the splenic artery. Therefore, surgeons should control the common trunk of the splenic artery to reduce blood loss and provide a safe operating environment. Briefly, the procedure is like that of an open splenectomy. The pulsed splenic artery can be located at the upper edge of the pancreas and dissected by excising the vascular sheath. The dissected splenic artery can be encircled by vascular occlusion tape and ligated using a Hem-o-lok device. Hem-o-lok clips can be removed directly using the harmonic scalpel. For an over-sized spleen, it may be easier to locate the splenic artery in the lesser sac after opening the gastrocolic ligament. Resection of the spleen lesion should be carefully performed. The above-mentioned hemostatic devices can be used to excise the splenic parenchyma. In cases with unclear anatomy of the splenic vessels, the clamp-crushing technique, used in liver resections frequently, can be used to excise the partial spleen. During the clamp-crushing process, some vessels may appear between the transverse sections and can be clipped by titanium clips or Hem-o-lok clips and excised. Complications, including bleeding, fluid, and abscess formations, are very rare. In this report, because the cyst was

large and splenic exposure under single-port conditions was difficult, no pretreatment was applied for the vessels at the splenic pole nor temporary clamping of the splenic artery trunk using the detachable endoscopic vessel clamp. They first suctioned the fluid from the cyst to collapse it, then opened the spleen parenchyma using a harmonic scalpel to allow careful separation. If blood vessels in the spleen parenchyma are unclearly defined, then the clamp-crushing technique was used, as described above. During the resection process, the arterial branch in the lower pole of the spleen can be exposed and truncated via ligation with a Hem-o-lok clip. The splenic cyst was gradually excised together with part of the spleen parenchyma using a harmonic scalpel. Even without pretreatment of the splenic blood vessels, bleeding can still be sufficiently controlled by fine separation of the spleen parenchyma, thus achieving partial spleen resection [23]. During SPLPS, it is very important to protect the surrounding organs of the spleen. The splenic mass can grow and compress these organs. Inflammatory adhesion around the spleen may be a result of concurrent local inflammation, which may increase the difficulty of surgery and even result in surgery failure. Therefore, preparation for conversion to open surgery should be made whenever SPLPS is performed.

Present findings suggest that SPLPS has the advantages of safety, efficacy, cosmesis, and less pain after surgery. However, many possible drawbacks to implementing this technique exist, including a difficult learning curve, compromises in exposure or visualization, increases in necessary equipment, and operative costs. Currently, there are relatively few reports regarding SPLPS or studies regarding the large-scale application of SPLPS, with clinical evaluations of the advantages and disadvantages of this technique compared with conventional laparoscopic splenectomies. Further studies and relevant comparative analyses are warranted.

Disclosure of conflict of interest

None.

Abbreviations

CT, Computed Tomography; LPS, laparoscopic partial splenectomy; LTS, laparoscopic total splenectomy; OPSS, overwhelming post-splenectomy sepsis; PS, partial splenectomy; SP-LPS, single-port laparoscopic partial splenectomy; SPLS, single-port laparoscopic surgery.

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