

Single incision laparoscopic cholecystectomy using the one-incision three-trocar technique with all straight instruments: how I do it?

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Abstract Single incision laparoscopic surgery (SILS) is a novel minimally invasive surgical technique that is gaining popularity around the world. One of the most commonly performed procedures is single incision laparoscopic cholecystectomy (SILC). Most reported techniques utilize special purpose-made access port and articulating instruments, rendering the procedure costly and difficult to learn. This article provides a stepwise description of SILC technique using all straight instruments without the need for a special port. It aims to shorten the learning curve for surgeons wishing to adopt a safe and cost-effective SILC technique to their practice.

Keywords laparoscopic cholecystectomy; single incision laparoscopic surgery

Introduction

Single incision laparoscopic surgery (SILS) is disseminating rapidly around the world, and one of the most commonly performed procedures is single incision laparoscopic cholecystectomy (SILC) [1,2]. SILC has the potential for improved cosmesis, faster recovery and decreased pain relative to conventional multi-port laparoscopic cholecystectomy (LC). However, there are intrinsic drawbacks of SILC such as significant instrument/hand collision and the loss of well-accepted concept of triangulation essential for appropriate operative exposure. A longer distance from the port of entry (umbilicus) to the operative site (gallbladder) adds further technical challenges to the procedure. All these issues potentially threaten the safety of SILC, deterring general surgeons from adopting this technique to their practice.

To overcome some of the above-mentioned technical challenges, much effort has been made by industry to modify equipment to accommodate SILC. Various ports, trocars, hand instruments and laparoscopes have been developed over the last several years [3]. They are not only expensive but also counterintuitive to surgeons who have adapted to standard laparoscopic equipment, thus precluding widespread

application of SILC. Numerous reports have described SILC techniques using various special ports and instruments, yet a detailed description of the operative steps of SILC using conventional instrumentation is lacking in the literature. This article provides stepwise description of a one incision, three-trocar SILC technique with all standard instruments. The objective is to ease the learning experience of surgeons wishing to adopt a safe and cost-effective SILC technique.

Patient selection

The indications for SILC should remain the same as those for multi-port laparoscopic cholecystectomy. Symptomatic cholelithiasis with or without chronic cholecystitis is the most common indication. Patients with biliary dyskinesia are also suitable candidates for SILC. Exclusion criteria include morbid obesity (BMI > 35), previous upper abdominal surgery, severe acute cholecystitis, suspected presence of common bile duct stones and gallbladder malignancy. Patients with gallbladder polyps should be advised to undergo multi-port LC, as gallbladder perforation and bile spillage may occur while retraction suture is placed through the gallbladder during SILC. Patients with liver cirrhosis should also be excluded for SILC due to risk of bleeding and difficulty in gallbladder retraction. The presence of large gallstones (above 2 cm) is not an absolute contraindication for SILC, but could pose technical challenges for surgical field

exposure. All patients should sign an informed consent for SILC with possible conversion to either multi-port LC or open cholecystectomy. The decision for SILC should be based on a sound judgment on the part of the surgeon rather than mere cosmetic preference of the patient. The safety of SILC should never be compromised for the purpose of achieving better cosmesis.

Operative technique

Instrumentation

The instruments and equipment for SILC is very similar to those for multi-port LC. The main difference is the utilization of an extra-long laparoscope. This can be achieved with a 50-cm long, 5-mm, 30-degree rigid bronchoscope (Karl-Storz, Germany) available in most hospitals. An L-shaped light-cord adaptor is added to move the hand of the camera person away from the operative field so as to yield more hand freedom for the surgeon. The availability of a high-definition (HD) camera along with an HD monitor is a plus but not necessary. The author utilizes a modified one-incision, three-trocar technique for all SILC as initially described by Curcillo and colleagues [4]. The optic trocar is a transparent 5-mm Xcel bladeless trocar with a side port for gas (Ethicon, Cincinnati, OH), and the two working trocars are 5-mm low profile ones. We choose the 5-mm Hunt Cannulas (Apple Medical, Marlborough, MA) as the working trocars for their small head and reasonable cost. Besides a standard diathermy hook, a suction-irrigation device is also preferable to remove smoke and clean the field. A retrieval bag is usually unnecessary, as the author enlarges the fascia incision for specimen removal in all cases.

Patient position and operating room set-up

The patient is placed in supine position on the operating table with the left arm tucked on the side of the torso. Prophylactic antibiotics is given within 30 min prior to making the skin incision. Compression boots are placed to bilateral lower extremities for the purpose of deep venous thrombosis (DVT) prophylaxis. A restraining belt is placed at the level of the upper thigh to secure the patient on the table as steep reverse Trendelenburg position is necessary for the majority of the procedure.

The surgeon stands on the left side of the patient while the assistant stands opposite to him during trocar insertion. Both the surgeon and the assistant stand on the left side of the patient during gallbladder dissection. The scrub nurse remains on the right side of the patient at all times. The TV monitor is placed above the patient's right arm, and an additional screen above the patient's left shoulder is optional. The foot paddle for the diathermy hook is placed next to the surgeon's right foot, and the suction-irrigator is easily reachable to the surgeon's right hand.

Skin incision and trocar placement

Using a No.11 blade, a 15 to 20 mm vertical transumbilical skin incision is made, and the dissection is then carried down through the conus to the deep fascia. Pneumoperitoneum is developed by directly inserting a Veress needle into the peritoneal cavity through the deep fascia. An initial 5-mm Xcel optic trocar is inserted in the inferior edge of the incision along the midline. The rigid bronchoscope is then introduced to inspect the abdomen and the gallbladder. After exclusion of access-induced injury and confirmation of optimal gallbladder condition, the Veress needle is removed. CO₂ pneumoperitoneum is maintained at 15 mmHg.

Small skin flaps about 1 cm × 1 cm are then raised on both sides of the incision superior to the optic trocar. The author prefers to detach the stalk of the umbilicus from the deep fascia and evert the umbilicus during this step. Two 5-mm Hunt Cannulas are then placed through separate fascial punctures superolaterally to the optic trocar. The two working trocars are aimed 45-degree laterally via the rectus muscle to achieve adequate triangulation and to avoid air leak. The entry of working trocars into the peritoneal cavity is directly monitored through the side of the transparent optic trocar. The three trocars are 1 cm apart in a triangulated arrangement. The external set-up is shown in Fig. 1.



Fig. 1 The external set-up. Three 5-mm trocars are placed in a triangulated arrangement via a single transumbilical incision. The two working trocars are aimed 45-degree laterally to traverse the rectus muscles. A 50-cm long, 5-mm 30-degree rigid bronchoscope with an L-shaped light cord adaptor is used to yield more external working space. The laparoscopic screen is placed above the patient's right arm. Both the surgeon and the assistant stand on the left side of the patient.

Gallbladder retraction suture placement

With the patient in steep reverse Trendelenburg position with slight left-sided tilt, a Keith needle attached to a No.1 silk suture is introduced into the peritoneal cavity at the right

subcostal area. Using a laparoscopic needle holder, the needle is guided to pass through the fundus of the gallbladder. The tip of the needle is then exteriorized through the abdominal wall next to the entry site. The suture is then tightened and secured externally with a hemostat clamp. This transabdominal suture maintains cephalad liver and gallbladder retraction throughout gallbladder dissection. If the gallbladder is long and floppy, the traction suture should be placed at the gallbladder body to achieve adequate cephalad retraction. In our experience, a second traction suture is rarely necessary. In the presence of omental adhesions to the gallbladder, the adhesions should be dissected off the gallbladder prior to placing the traction suture.

Gallbladder dissection

To minimize material cost of the procedure, dissection is performed using all straight laparoscopic instruments. With proper trocar arrangement, adequate triangulation can be achieved and no crisscross hands are necessary. The left-side working trocar is used for retraction with a grasper, and the right-side working trocar is used for dissection with a diathermy hook. The suction-irrigation device is used for removing smoke and cleaning the field as needed.

Dome-down laparoscopic cholecystectomy has been demonstrated as a safe method to approach the cystic duct in cases of difficult anatomy in order to prevent bile duct injuries and to reduce the conversion rate [5,6]. This approach allows the opportunity to evaluate the cystic duct circumferentially prior to its division, and thus minimize the risk of bile duct injury secondary to anatomical misidentification [6]. The author developed a modified dome-down technique for safe dissection [7]. Leaving the gallbladder fundus still attached to the liver bed to maintain liver retraction, dissection is first carried out in the gallbladder body. The peritoneal reflections are incised both medially and laterally, and a window is then created between the gallbladder body and the liver bed. This is achieved by alternating medial and lateral retraction of the gallbladder (Fig. 2, A and B). Inadvertent clashing between the camera and the working instruments is minimized by verbal instructions to the assistant, so that a change in angle of dissection is anticipated and the camera position is adjusted accordingly.

After the through-and-through window is created, dissection is then carried down retrograde toward the porta hepatis (Fig. 3A). Meticulous hemostasis is achieved at all times. Once the gallbladder infundibulum is reached, lateral and slightly caudal retraction of the gallbladder allows maximal opening of the Calot's triangle. The cystic artery and the cystic duct are then skeletonized. The cystic artery is usually clipped and transected first for better visualization of the cystic duct, especially if it is located anterior to the cystic duct. A small cystic artery can be cauterized at two separate points and transected in between safely using the diathermy

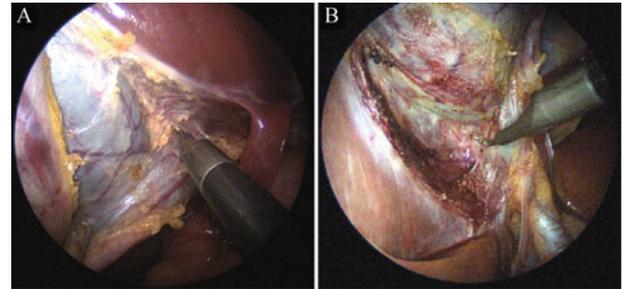


Fig. 2 Gallbladder dissection using a modified dome-down approach. (A) Medial dissection by retracting the gallbladder laterally. (B) Lateral dissection by retracting the gallbladder medially.

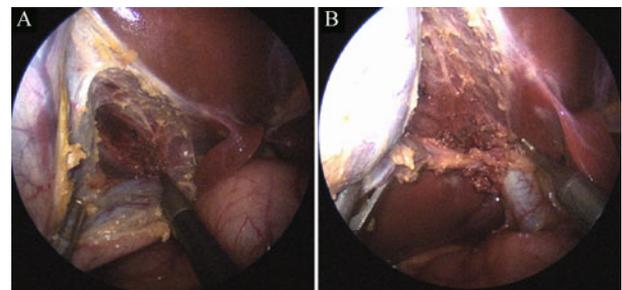


Fig. 3 (A) A window is created between the gallbladder body and the liver bed prior to retrograde dissection toward the porta hepatis. (B) The skeletonized cystic duct (the cystic artery has been cauterized and transected).

hook. At this point, a 360-degree view of the gallbladder-cystic duct junction is usually achieved (Fig. 3B). Medial retraction of the infundibulum is sometimes necessary to establish whether it is adherent posteriorly to the bile duct. The cystic duct is then clipped and transected in the usual fashion. After final confirmation of satisfactory hemostasis on the gallbladder fossa, the gallbladder is freed from the liver bed by separating the attachments near the fundus.

Specimen retrieval

Following adequate lavage and aspiration of all free fluid in the perihepatic space, the camera is then inserted into one of the working trocars. A 5-mm tooth-grasper with ratchet is then introduced through the midline optic trocar to grasp the cystic duct stump on the gallbladder side, and the gallbladder is retracted toward the umbilical incision following removal of the transabdominal suture. The midline fascial defect is then appropriately enlarged over the trocar cannula for specimen retrieval. An extraction bag is usually unnecessary. However, in the presence of acute cholecystitis, a retrieval bag should be used to minimize the incidence of wound

infection. In this case, inserting a 10–12 mm trocar following proper enlargement of the fasciotomy at the site of the optic trocar is required.

Layered closure of umbilical incision

Meticulous closure of all fascial defects is mandatory to prevent incisional hernias at the umbilicus. The author closes the fascial defects with interrupted No. 0 vicryl sutures. In the presence of a preexisting umbilical hernia, fascia closure using non-absorbable sutures is advised. The subcuticular layer is then closed with interrupted 4-0 monocryl, and the umbilical stalk is reattached to the deep fascia during this step. The appearance of skin closure is shown in Fig. 4. Following application of antibiotic ointment (e.g. bacitracin) over the skin incision, a small compressive dressing with a cotton ball and a Tegaderm is placed over the umbilicus to minimize the incidence of seroma.

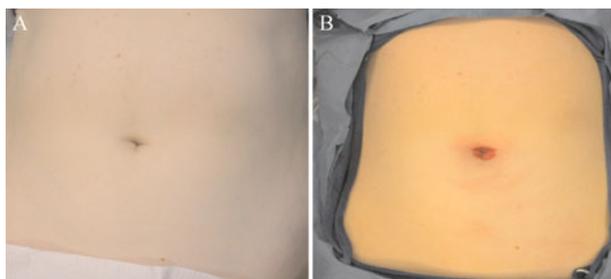


Fig. 4 Comparison of skin appearances before and after surgery. (A) Skin appearance before surgery; (B) Wound appearance immediately after skin closure with expected bruises.

Postoperative care

The postoperative care for SILC is virtually identical to that of patients undergoing multi-port LC. Patients are allowed to ambulate and take clear liquids within 4–6 h after surgery and discharged within 24 h. Oral analgesics are prescribed upon discharge, and no postoperative antibiotics are necessary. Patients are advised to shower in 48 h with the dressing on, and to remove the umbilical dressing on the fifth postoperative day. Clinical follow-ups are usually scheduled in four weeks after surgery.

Author's experience with SILC

Between May 2009 and February 2011, the author performed a total of 125 SILC. Only one case was converted to a standard multi-port LC due to the presence of severe acute calculous cholecystitis. All other cases were completed successfully without the need for adding additional ports.

The mean age of the patients was 32 (range 21–56) years, and the mean body mass index (BMI) was 26.3 (range 17.4–33.8). The mean operating time was 61 min (range 55–120), and blood loss was minimal in all cases. All patients were discharged home within 24–48 h postoperatively. One patient was complicated with a postoperative duct of Luschka leak, requiring readmission, ERCP and drainage of bile collections. Follow-up at one month on all patients revealed a barely visible scar within the umbilicus (Fig. 5). There was no wound complication (such as seroma, infection or skin necrosis) in the author's series. With the longest follow up of 22 months, no patient has presented with incisional hernias. The author's early experience with SILC has been accepted for publication in *Surgical Endoscopy* [7].



Fig. 5 Wound appearance at four-week follow-up. Scars are barely visible within the umbilicus.

Summary

The one-incision three-trocar SILC technique using all straight instruments is a feasible approach. The author's unique modified dome-down dissection renders this procedure safe because of excellent delineation of ductal anatomy. Surgeons with experience on multi-port LC can adopt this technique without a significant learning curve. Since there are no special ports/instruments necessary for this technique, the material cost remains similar to that of standard multi-port LC. Hitherto, there is a potential for rapid dissemination of this technique in developing countries including China.

References

1. Romanelli JR, Earle DB. Single-port laparoscopic surgery: an overview. *Surg Endosc* 2009; 23(7): 1419–1427
2. Hernandez JM, Morton CA, Ross S, Albrink M, Rosemurgy AS. Laparoendoscopic single site cholecystectomy: the first 100 patients. *Am Surg* 2009; 75(8): 681–685, discussion 685–686
3. Ponsky TA. Single port laparoscopic cholecystectomy in adults and children: tools and techniques. *J Am Coll Surg* 2009; 209(5): e1–e6
4. Podolsky ER, Rottman SJ, Poblete H, King SA, Curcillo PG. Single

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- port access (SPA) cholecystectomy: a completely transumbilical approach. *J Laparoendosc Adv Surg Tech A* 2009; 19(2): 219–222
5. Mahmud S, Masaud M, Canna K, Nassar AHM. Fundus-first laparoscopic cholecystectomy: a safe means of reducing the conversion rate. *Surg Endosc* 2002; 16(4): 581–584
 6. Tuveri M, Calò PG, Medas F, Tuveri A, Nicolosi A. Limits and advantages of fundus-first laparoscopic cholecystectomy: lessons learned. *J Laparoendosc Adv Surg Tech A* 2008; 18(1): 69–75
 7. Cui H, Kelly JJ, Litwin DEM. Single incision laparoscopic cholecystectomy using a modified dome-down approach with conventional laparoscopic instruments. *Surg Endosc* (in press)