Evaluation of the role of single incision laparoscopic cholecystectomy (SILC) for the management of chronic calculous cholecystitis

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Background: *Laparoscopic cholecystectomy has become the gold standard for cholecystectomy. Single-incision laparoscopic operations have recently emerged as a less invasive alternative to conventional laparoscopy as the tendency of minimizing surgical trauma encourages the use of new approaches in laparoscopic surgery which has the potential of further reducing the trauma of surgical access. This may lead to reduced post operative pain and improved patient cosmesis. Single-incision laparoscopic surgery (SILS) is a rapidly evolving field as a bridge between traditional laparoscopic surgery and natural orifice transluminal endoscopic surgery (NOTES). The aim of this work was to evaluate the role of SILC for the management of chronic calculous cholecystitis as regards its feasibility and outcome.*

Patients and methods: *Between January 2010 and January 2014, 120 patients were subjected to SILC. A single 2.5cm long semicircular supraumbilical skin incision was used. Pneumoperitoneum was established with the Veress access needle. Abdominal cavity was entered through three trocars: 10-mm trocar for camera and two 5-mm trocars, each placed 1-2cm laterally and cranially from the 10-mm trocar, with carefully placed sutures to puppeteer the gall bladder and thus aid retraction.*

Results: *In this series, out of 120 patients, 90 patients (75%) were females, and the remaining 30 patients (25%) were males, with an average age of 32.8 years (range, 23-60 years), and 36 female patients had undergone previous lower abdominal surgery (Cesarean section or other gynecological procedures). Mean operative time was 58.6 min (range 40-120 min). Out of 120 patients, 106 patients (88.3%) successfully underwent SILC. In 10 patients (8.3%) an additional epigastric port was used, in 3 patients (2.5%) conversion to the traditional 4-port laparoscopic technique was done, and conversion to open surgery was done in one patient.*

Conclusions: *SILC using conventional laparoscopic instrumentation is an effective alternative to standard four-incision laparoscopic cholecystectomy in selected patients, it is safe, feasible, and reproducible. The operating times are reasonable and can be lessened with experience.*

Key words: *Laparoscopic cholecystectomy; single-incision laparoscopic surgery; single-incision laparoscopic cholecystectomy; natural orifice transluminal endoscopic surgery.*

Introduction:

Chronic calculus cholecystitis has been encountered as a common health problem, at first it was treated by open procedure but really this procedure has a lot of disadvantages like ugly scar, possibility of developing hernia, post operative pain, and long stay in hospital.[1] With the advent of laparoscopy, laparoscopic surgical techniques have transformed much of surgery over recent decades, this minimal access techniques allow extensive operations to be performed with little trauma.[1] Thus enabled this procedure to gain rapid worldwide acceptance as a result of better cosmetic results, less post operative pain, and shorter recovery time than with open procedures.[2]

Since the introduction of laparoscopic

cholecystectomy as the gold standard procedure to remove the gallbladder, many surgeons have attempted to reduce the number and size of ports in laparoscopic cholecystectomy to decrease parietal trauma and improve cosmetic results.These efforts are some of the fundamentals of the natural orifice trans-luminal endoscopic surgery (NOTES) approach,[3-6] which removes trans-abdominal incisions completely, but NOTES is technically challenging and current instruments needed to be further improved. As a bridge between traditional laparoscopic surgery and NOTES, the recent focus has been on the development of single-incision laparoscopic surgery (SILS) to further minimize the invasiveness of laparoscopic surgery by reducing the number of incisions.[7]

Single incision laparoscopic surgery (SILS) was developed with the aim of reducing the invasiveness of traditional laparoscopy. It can be performed using the same instruments used for conventional laparoscopic procedures, surgeons can perform SILS without any new instruments, SILS may offer the advantages of reduced postoperative pain and more cosmesis.[1] SILC appears to provide outcomes similar to standard laparoscopic cholecystectomy, technically feasible alternative, but it is more difficult.[2]

First experience with SILC was reported by Navarra et al[8] and with a different approach by Piskun and Rajpal.[9] Technical limitations postponed the full extent of its application until recently, when articulating and bent laparoscopic instruments and modified ports have become commercially available.[10]

We reported a series of 120 single-incision laparoscopic cholecystectomies utilizing a single umbilical incision to evaluate its role in management of chronic calculus cholecystitis. Primary end points were feasibility and safety. We described the challenges that we faced and the evolution of our techniques.

Patients and methods:

Patient selection: Between January 2010 and January 2014, 120 patients with chronic calculus cholecystitis (proved by ultrasound) were admitted to the Upper Gastrointestinal Surgery Unit, Alexandria Main University Hospital. They underwent single-incision laparoscopic cholecystectomy. Patients who underwent this procedure were informed about the procedure, and an informed consent was obtained from every patient before carrying the procedure.

Operative technique: Patients were positioned on the operating table in a reverse Trendelenburg, right side up position. Patients were draped in a standard manner. A single semicircular supraumbilical skin incision 2.5 cm long was made. The incision should not breach the umbilical ring. After exposing the fascia, a Veress needle was placed into the peritoneum and insufflated up to 15 mm Hg with CO_2. Three ports were placed within the umbilical incision in a triangular configuration (single incision), one 10-mm trocar through which a 10-mm 30-degree camera was then introduced and the abdominal cavity was explored. Two 5-mm trocars each placed 1-2cm laterally and cranially from the 10-mm trocar **Figure (1)**, or single port technique that allows insertion of two hand instruments and an optic through the same port **Figure (2)**. The first operator should now stand between the patient's legs with the assistant holding the laparoscope on the patient's left hand side.

Retraction and manipulation of the gallbladder were achieved with the use of (2/0 prolene; Ehicon) on a straight cutting needle introduced through the abdominal wall. These sutures were passed through the gallbladder before being pushed out of the abdominal cavity again. Careful suture placement allows the operator to "puppeteer" the gallbladder thus replicating the movement that would normally be performed by the surgeon's left hand in a traditional laparoscopic cholecystectomy.

We choose to place our sutures in the following manner. The fundus of the gallbladder was grasped and elevated to the anterior abdominal wall. The fundus was pushed cranially to demonstrate the desired exposure of the undersides of the gallbladder and liver. Simultaneous palpation of the

abdominal wall demonstrates the optimum site for insertion of the first suture, which was placed as high as possible while avoiding the pleura. A 2/0 prolene suture on a straight cutting needle was pushed vertically down into the abdomen under direct laparoscopic surveillance, the needle was taken by a laparoscopic needle-holder and passed through the fundus of the gallbladder before being passed back up through the abdominal wall as close as possible to the point of entry. The second suture was introduced in the epigastric region under direct vision. A laparoscopic needle holder was used to pass the suture needle through the Hartmann's pouch, the needle was then passed out through the lateral right abdominal wall (when needed). Intra-abdominally, titanium clips were placed on the suture at the entry and exit points from Hartmann's pouch using a clip applicator.

Dissection of the Calot's'triangle now can proceed. The goal of operative procedure was the same as with the conventional laparoscopy, i.e., dissection of the gall bladder until the critical view of safety was obtained, followed by transection of cystic duct and artery and removal of the gallbladder. The critical view of safety was obtained when the triangle of Calot was dissected free of all tissues, except for the cystic duct and artery, and the base of the liver was exposed. This was done by dissection of the gallbladder hilum with a Maryland dissector to expose the cystic duct and artery which were clipped using a 5-mm clip applier, and then divided with scissors, or by using 5-mm 30 degree camera and 10-mm clip applier, or by using the Harmonic Scalpel (Ethicon Endo Surgery) which is known as clipless laparoscopic cholecystectomy.

Dissection of the gallbladder off the liver bed was performed with the Maryland dissector and hook electrocautery. At this point, the 10mm camera was exchanged by 5mm camera, and the gallbladder was then extracted from the abdominal cavity through the 10-mm port.

Results:

Operative Results: One-hundred and twenty patients were selected to undergo single-incision laparoscopic cholecystectomy between January 2010 and January 2014. Out of 120 patients, 90 patients (75%) were females, and the remaining 30 patients (25%) were males, with an average age of 32.8years (range, 23-60 years), and 36 out of 90 female patients (40%) had undergone previous lower abdominal surgery (Cesarean section or other gynecological procedures). Mean operative time was 58.6 min (range 40-120 min).

Out of 120 patients, 106 patients (88.3%) successfully underwent single-incision laparoscopic cholecystectomy either through a three-channel device or three individual trocars. The three-port technique, with placement of the camera inferiorly and the two working ports at 2 and 10 o'clock, was the most consistently successful arrangement in our series. This arrangement allowed for ergonomics similar to conventional laparoscopy, with the surgeon using two hands to control inline, un-crossed instruments. Using this technique, we rarely required more than one retraction suture of the remaining patients, an additional epigastric 5mm working trocar was used in 10 patients (8.3%) due to failure to progress in a reasonable time, and difficulty to obtain safe dissection of the cystic duct and artery particularly in the early learning curve. In 3 patients (2.5%), conversion to the standard four-port laparoscopic cholecystectomy due to dense adhesion as a results of acute cholecystitis, and therefore difficult to identify anatomic landmarks through the single-incision technique. In one patient (0.83%) conversion to open cholecystectomy was required due to suspected common bile duct injury at the time of dissection of the cystic duct, after conversion; with careful dissection of the cystic duct, the tear was found in the cystic duct near its junction with the common bile duct, but it was still safe to close the cystic duct with running suture without encroaching on the common bile duct with the help of intra-operative cholangiogram.

Early complications: Three patients suffered from early complications, one female patient had asymptomatic seroma at

the port-site, and she was treated by aspiration and prophylactic antibiotic. The other two patients had port-site wound infections, requiring a course of antibiotic and frequent daily dressings. All patients returned to their preoperative activity level.

Delayed complications: Follow up information from the clinic visits one month up to six months post-operatively was available for the majority of patients (112 patients).

Four patients had late complications. One female patient who was a 40-year old returned back to the Emergency Department three weeks post- operative with right upper quadrant pain and fever. The white blood cell count was elevated to 24,000/cmm. Computed tomography demonstrated 3x2cm fluid collection within the gall bladder fossa. She was treated empirically with intravenous antibiotic after performing ERCP that showed no leakage and the patient was discharged to her home on hospital day 3 on oral antibiotic.

Two patients presented with right upper quadrant pain associated with nausea and vomiting with mild elevation of serum bilirubin and alkaline phosphatase. Ultrasonography showed no abnormal signs in the two patients, however magnetic resonance cholangiopancreatography (MRCP) showed a retained common bile duct stone; ERCP with sphincterotomy and stone retrieval was performed and the two patients were discharged from the hospital.

The last patient returned back after 6 months with an incisional hernia at the port-site, she was treated by mesh repair.

Discussion:

SILC is a new step in minimally invasive surgery. The fact that laparoscopic cholecystectomy is currently the gold standard and is performed literally at almost every hospital worldwide, being considered safe and cost effective, should not prevent its further technical evolution. The benefit of transition from standard laparoscopic approach to SILC will not be as visible as it was for the transition from open to laparoscopic cholecystectomy. However, as stated in a study performed by Bisgaard et al,[11] further minimization is justified. It cannot be over stated that every incision and trocar placement poses a risk of bleeding, organ damage and incisional hernia. Moreover, since cosmetic effect is increasingly important to patients, we should not neglect cosmetic improvement with SILS, especially when SILS is performed within the umbilicus.[12,13]

Single-incision transumbilical laparoscopic cholecystectomy was first described in Italian literature in 1995.[8] In 1997, Navarra et al[8] published the first case series of 30 patients who underwent what they described as "one-wound laparoscopic surgery". In the last several years, there has been a resurgence of popularity of SILS. Gumbs et al[14] Cuesta et al[15] and the most recently Tacchino et al[2] have reported their experience with single incision transumbilical laparoscopic cholecystectomies. Although NOTES was introduced as a new surgical concept that would share the same benefits conferred by conventional minimally invasive surgery but without scars and perhaps with considerable minimal pain to none at all.[16-20] But all these theoretical advantages have spurred widespread research and investigation forward, with extensive financial and scientific investment allocated to NOTES. In contrast to NOTES, SILS does not require the opening of hollow organ, such as stomach, colon, or vagina. Thus, complication related to visceral closure, such as gastrotomy or colostomy leakage, are avoided. Moreover; in SILS access to the abdominal cavity is obtained by one small incision, which is concealed perfectly when placed transumbilical. Through this one port, several instruments can be inserted and changed without loss of pressure of the pneumoperitoneum.[21,22]

Performing laparoscopic surgery through SILS seems more intuitive than NOTES, especially for the surgeons who routinely perform laparoscopic surgery and may not have the sophisticated infrastructure that NOTES may require. This surgical concept of laparoscopy through a single incision seems itself a bridge to NOTES because it promises the absence of visible scar and potentially

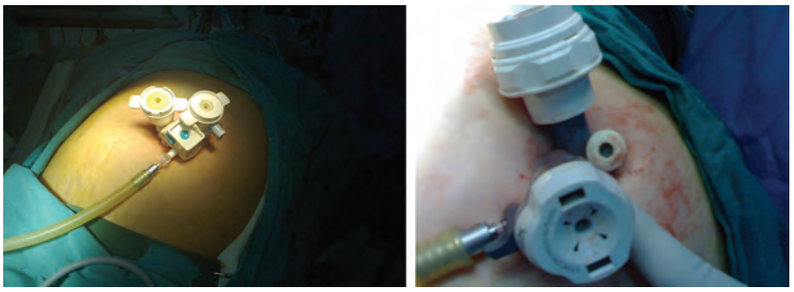

Figure (1): Single incision laparoscopic cholecystectomy.

Figure (2): Single port laparoscopic cholecystectomy.

less pain than conventional laparoscopy.[23,24]

The major difficulty with SILS stems from the need for the surgeon to adapt to the new method of instrumentation. The SILS technique is not naturally ergonomic technique because the traditional laparoscopic principles of triangulation are lost, because both the operating instruments and laparoscope are introduced through the same incision, and on the same axis, the operator and assistant often impede the movements of each other. This is not helped by current instrumentation, which has not been designed with the single-incision approach in mind. Instruments often interfere with each other not only within the abdomen but also extra-abdominally, where attachments such as the camera light lead often impede movements.[25] And that we had faced at the beginning of our work, and at the use of the three-channel device. This makes clear and accurate communication between the surgeon and assistant essential.

In our series, the use of 2- to 3-cm periumbilical incision consistently allowed for the placement of up to three trocars in a single skin incision, with approximately 3-cm distance between trocars. The three-port technique, with the placement of the camera inferiorly and the two working ports at 2 and 10 o' clock, was the most consistently successful arrangements in our series. This arrangement allowed for ergonomics similar to conventional laparoscopy, with the surgeon using two hands to control inline, uncrossed instruments. We experienced some difficulties in obtaining a satisfactory exposure, when several adhesions between the duodenum, the inferior aspect of the liver and the gallbladder particularly in the presence of acute or sub-acute inflammation or distended transverse colon covered the infundibulum, therefore in certain cases we needed to add additional trocar in the epigastrium in 10 patients, or we used the original four trocars technique in 3 patients.

At the end of the procedure, a careful reconstruction of the umbilicus will allow it to be replaced to its original position, thus achieving a completely invisible scar. The percutaneous stitches used for gallbladder suspension leave no scar in the abdominal wall, and thus we can claim a "non visible scar" procedure.

Our results are similar to those previously presented in the literature,[15,21,24] we used the conventional laparoscopic instruments, we did not perform intra-operative cholangiograms (IOC) during the procedure of SILC. Over

the course of this series, our operative time improved from an average 120 minutes for the first quarter of cases, to an average 80 minutes for the second quarter of cases, to an average 55 minutes in the third quarter, and to just 40 minutes for the final quarter. We experimented in the beginning with different techniques including retraction with two stay suture, then retraction with only one stay suture placed at the fundus, the use of the three-channel device, Harmonic scalpel and the use of 5mm clip applier. However it quickly became obvious that the use of single retraction suture, three port SILS, and the use of Harmonic scalpel facilitate the ease of dissection and removal of the gallbladder. We have also adopted the use of an extracorporeal stay suture to assist in cephalad retraction, and there was a minimal bile spillage from the placement of this stitch.

In our experience good haemostasis is essential for SILC till the critical view of safety is obtained at the time of removal of the gallbladder from its bed. If haemostasis is difficult to control with SILS approach, we advocate the insertion of additional laparoscopic trocars, with conversion to an open procedure if deemed necessary.

To conclude, SILS should be done by surgeons experienced in laparoscopy. Proper patient selection is also of great importance to reduce the rate of conversion until acquiring adequate experience as a result of the conflict between the operative instruments, and the camera and the smaller degree of instrument triangulation compared to that of conventional laparoscopic surgery.

Despite this limitation, single-incision laparoscopic cholecystectomy is safe, feasible, and quite reproducible in experienced hands. This technique can be applied for the management of patients in outpatient surgery centers because most of them may not have a complex disease. Furthermore, with progressive experience, more complex patients may be suitable candidates for this technique. The outcomes seem comparable with those of conventional laparoscopic techniques, with similar minimal morbidity and no mortality in our series.

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