RESEARCH ARTICLE

Laparoscopic Cholecystectomy: Single-port vs Traditional Procedure: Our Experience

Selmy Mohamed Awad[1], Ibrahim Dawoud[2], Waleed Althobiti[3], Shaker Alfaran[4], Saleh Alghamdi[5], Saleh Alharthi[6], Khaled Alsubaie[7], Soliman Ghedan[8], Rayan Alharthi[9], Majed Asiri[10], Azzah Alzahrani[11], Nawal Alotaibi[12], Mohamed Shetiwy[13]

Abstract

Background: Laparoscopic surgery is widely accepted as a reliable alternative to the open approach across surgical disciplines. Benefits of single-incision laparoscopic surgery (SILS), as exemplified here by single-port laparoscopic cholecystectomy (SPLC), have yet to be formally proved. However, the hypothesized benefits of SILS would include those of standard traditional laparoscopic surgery plus improved esthetic outcomes, with surgery being performed through a single hidden incision.

Methods: All patients who had chronic calcular cholecystitis at the General Surgery Department at Mansoura University Hospital between May 2014 and May 2018 were eligible for this study to compare SPLC with multiport laparoscopic cholecystectomy (MPLC). Operative and perioperative outcomes, including cosmesis, were analyzed.

Results: SPLC had been performed in Group A (40 patients), mean age was 37.35 ± 10.72, 80% were females, and mean BMI was 30.15 ± 4.53. MPLC was performed in Group B (40 patients), mean age was 40.70 ± 9.71, 75% were females, and mean BMI was 28.35 ± 2.83. The average duration of postoperative hospital stay in SPLC cases was 24 hours and in MPLC group was 25.20 hours, with $p = 0.330$, which was insignificant. In the SPLC group, the mean operative time was 95.75 minutes whereas in the MPLC group the mean operative time was 42.10 minutes. Therefore, the mean operative time in the SPLC group was significantly higher than in the MPLC group ($p < 0.01$). Esthetic results were better in the SPLC group than in the MPLC group.

Conclusion: Based on the current findings, SPLC seems to be a safe procedure in uncomplicated cholecystitis with rapid recovery, less postoperative pain, less wound infection, and better cosmesis. The operative time was long. However, patients should be aware of the risks of port-site incisional hernia and instructed to avoid heavy work and exercises during the first three postoperative months.

Keywords: Laparoscopic cholecystectomy, Single-port, Traditional.

World Journal of Laparoscopic Surgery (2021): 10.5005/jp-journals-10033-1482

Introduction

Laparoscopic surgeries are special techniques by which surgeons perform the operations via several tiny holes in the abdomen with the help of a camera. It is known also as minimally invasive surgery (MIS). These incisions are much smaller than traditional surgical techniques.[1]

Diminished postoperative pain, fast recovery, improved esthetic outcomes, and short hospital stay are the documented benefits across a spectrum of surgical procedures. Many procedures have been done safely with laparoscopy. These include laparoscopic cholecystectomy that has supplanted open cholecystectomy for most gallbladder pathologies.[2,3]

Laparoscopic cholecystectomy is a widely accepted procedure that causes less postoperative pain and a shorter postoperative length of stay (LoS) than open surgery.[4–8] Traditional laparoscopic cholecystectomy is done in >90% of elective cholecystectomies and 70% of urgent cholecystectomies.[9,10]

The concept of SILS is to do the procedure through a single skin incision, usually the umbilicus through multichannel (trocar) ports. The umbilicus is the common site for basic procedures such as laparoscopic cholecystectomy and appendectomy. The incision can be periumbilical or transumbilical.[11,12]

SILS is a quickly growing procedure as a union between traditional laparoscopic techniques and Natural orifice transluminal endoscopic surgery (NOTES). The current trend has been about the development of SILS to further reduce the invasiveness of laparoscopic surgeries by minimizing the number of skin violations.[13,14]

[1,2,13]Department of General Surgery, Mansoura University Hospitals, Mansoura, Egypt

[3–12]Department of General Surgery, King Faisal Medical Complex, Taif, Saudi Arabia

Corresponding Author: Selmy Mohamed Awad, Department of General Surgery, Mansoura University Hospitals, Mansoura, Egypt, Phone: 0556466097, e-mail: selmysabry2007@yahoo.com

How to cite this article: Awad SM, Dawoud I, Althobiti W, *et al.* Laparoscopic Cholecystectomy: Single-port vs Traditional Procedure: Our Experience. World J Lap Surg 2021;14(3):221–226.

Source of support: Nil

Conflict of interest: None

Since 1985, many efforts have been on in the laparoscopy field to reduce the invasiveness of laparoscopic approaches, with operators developing new technology and techniques to minimize postoperative pain and improve esthetic outcome by small-sized ports or smaller numbers. At present, SILS has gained tremendous focus for the treatment of many surgical diseases.[5,15–17]

The difficulties of SILS include limited triangulation between straight instruments, restricted movements, close proximity between the instruments, and narrow visual axis and operative field.[18–20]

However, there are no clear indications for SILS until now, and its applicability and feasibility have grown throughout many of the surgical fields. The applicability of this approach has been

observed in gynecologic, urologic, pediatric, gastrointestinal, and bariatric surgery.[13]

Patients and Methods

All patients who had chronic calcular cholecystitis at the General Surgery department 7 at Mansoura University Hospital between May 2014 and May 2018 were eligible for this study to compare between SPLC and MPLC. Operative and perioperative outcomes, including cosmesis and quality of life, were analyzed. Candidates were randomly assigned into two groups: Group A consisted of 40 cases (single-port laparoscopic cholecystectomy) and Group B consisted of 40 cases (traditional multiport laparoscopic cholecystectomy).

Inclusion criteria: (1) age: ≥15 years, (2) sex: male and female, (3) ultrasound finding of gallbladder stones, (4) biliary colic, and (5) BMI <40.

Exclusion criteria: (1) age: <15 years, (2) acute pancreatitis, (3) common bile duct stones, (4) contraindications for single-port cholecystectomy, namely, ASA classification of 3 or 4 indicating pregnancy, and (5) BMI >40.

All candidates underwent proper history taking, thorough clinical examination, radiological, and full laboratory investigation stressing on liver status.

Follow-up of the patients: Follow-up of the patients included operative time, periprocedural operative complications (bleeding, bile leak, visceral injury, conversion to MPLC or open cholecystectomy). Postoperative follow-up included postoperative bleeding, bile leak, hospital stay, wound infection, incisional hernia, and cosmesis for one year. All of these data were collected, tabulated, and analyzed carefully using SPSS version 26.

Results

This comparative prospective research was performed on all eligible candidates who were classified into two groups: Group A consisted of patients who underwent single-port laparoscopic cholecystectomy and Group B consisted of patients who underwent multiport laparoscopic cholecystectomy.

Demographic Criteria and Clinical Characteristics of the Patients

Demographic and clinical characteristics of the patients are shown in Table 1. Patients in both groups had same abdominal sonography finding, such as normal liver, gallbladder stones, normal common bile duct diameter with no stones impacted, and so on. Laboratory investigations for patients in both groups were normal including serum bilirubin, serum alkaline phosphatase, liver enzymes, bleeding profile, and hemoglobin level. All cases with symptomatic cholelithiasis and all surgeries were elective.

Operative time: In Group A, the mean operative time in minutes was 95.75 ± 18.37 (Table 2) whereas in the MPLC group, it was 42.10 ± 5.04, so that the mean operating time in Group B was significantly lower than in the SPLC group (p <0.01).

Operative times and learning curve: The operative time was significantly higher in Group A (Fig. 1). An important reduction in the operative time was achieved as the number of cases undergoing SPLC had increased. In the first 20 cases, the average operative time was 100 minutes whereas in the second 20 patients, it was 80 minutes (Fig. 2).

Intraoperative complications: In the SPLC group, we encountered intraoperative bleeding in one case. The source of bleeding was a cystic artery, and we had to convert to MPLC to control the bleeding whereas in the MPLC group there was no intraoperative bleeding (p = 0.311) which is insignificant (Fig. 3). There was no intraoperative viscus injury or bile leakage in both groups.

Conversion to MPLC: In the SPLC group (Fig. 4), the conversion to MPLC was mandated in five patients. In one patient, it was due to uncontrolled bleeding from a cystic artery. In two patients, conversion was due to a tense gallbladder with pericholecystic adhesions and exposure of Calot's triangle was difficult. Both patients were male and had a history of recent attack of acute cholecystitis. In one patient, there was a caterpillar hump anomaly of the right hepatic artery occupying most of the cholecystohepatic triangle and so we had to convert for better delineation of Calot's triangle and safe cholecystectomy. In one patient, we converted to MPLC then to open procedure due to a thick gallbladder with an impacted large stone at the cystic duct.

Postoperative complications (bleeding, bile leak): In both groups, we did not have postoperative bleeding or bile leak.

Postoperative pain and need for additional analgesia: All patients in both groups received the same postoperative analgesia (paracetamol injection 8 hourly). In the SPLC group, the number of patients requiring additional analgesia in the form of NSAIDS was 16 (40%) whereas in the MPLC group, the number of patients requiring additional analgesia was 30 (75%) (p = 0.025), indicating

Table 1: Demographic and clinical characteristics of the patients

	SPLC group (n = 40)		*MPLC group (n = 40)*		*t*	*p*
Age (mean ± SD), years	37.35 ± 10.72		40.70 ± 9.71		1.036	0.307
BMI (mean ± SD)	30.15 ± 4.53		28.35 ± 2.83		1.506	0.140
Sex	*No.*	*%*	*No.*	*%*		
Male	8	20%	10	25%	0.143[#]	0.705
Female	32	80%	30	75%		
Recent attack of acute cholecystitis or pancreatitis	6	15%	4	10%	0.229	0.633

Table 2: Operative time in SPLC group and MPLC group

	Group A (n = 40)	*Group B (n = 40)*	*t*	*p*
Operative time (mean ± SD)	95.75 ± 18.37	42.10 ± 5.04	12.594	<0.01*

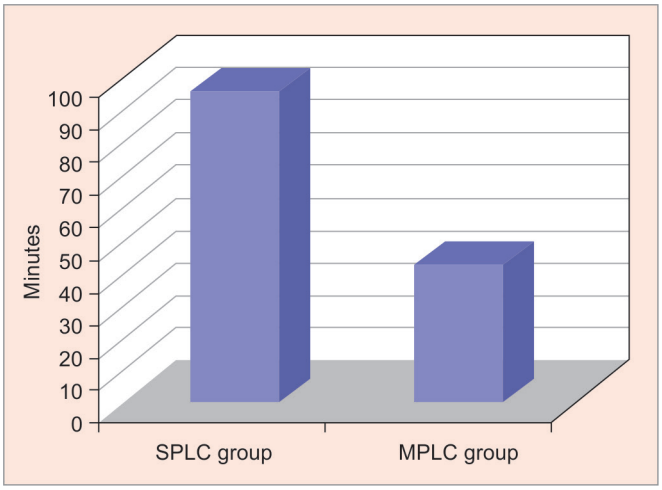


Fig. 1: postoperative time in SPLC and MPLC groups

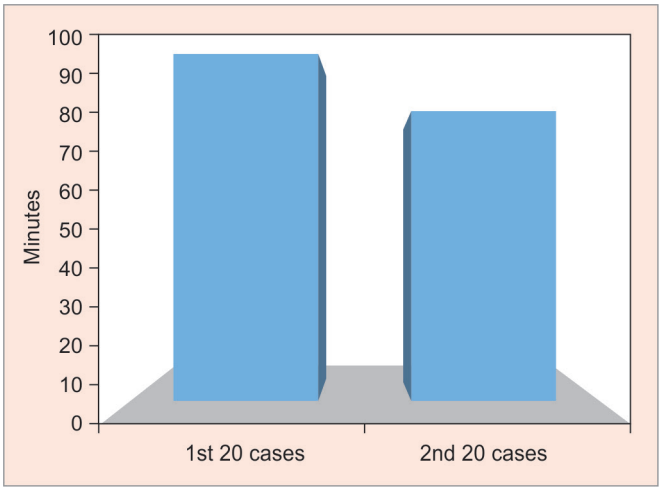


Fig. 2: Operative time and learning curve in SPLC group

that postoperative pain in SPLC is not significantly less than in the MPLC group. The data are shown in Table 3.

Postoperative of LoS: The mean duration of *LoS* in Group A was 24 hours whereas in Group B it was 25.20 hours (Table 4); *p* was 0.330 which is insignificant.

Postoperative wound infection: In the SPLC group, we observed wound infection in two patients (5%) whereas in the MPLC group wound infection occurred in eight patients ($p = 0.151$). In the SPLC group, the wound infection was mild and managed by oral antibiotics whereas in the MPLC group wound infection was at the site of the epigastric port (Fig. 5). In the eight patients, port-site wound infections were observed because the gallbladder had been perforated during specimen extraction and it was resolved with oral antibiotics.

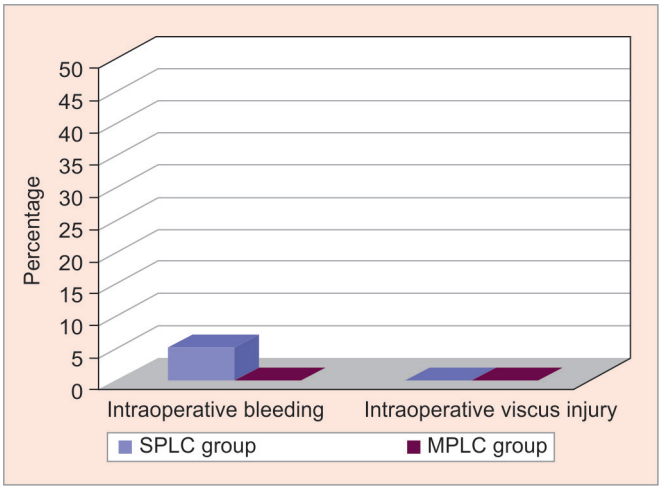


Fig. 3: Intraoperative complications of both groups

Table 3: Post-procedural pain in the two groups

	SPLC group (n = 40)		*MPLC group (n = 40)*			
	No.	*%*	*No.*	*%*	x^2	*p*
Need for NSAIDS	16	40%	30	75%	5.013	0.025

Table 4: Postoperative LoS in SPLC and MPLC groups

	SPLC group (n = 40)	*MPLC group (n = 40)*	*t*	*p*
Hospital stay (mean ± SD)	24.00 ± 0.00	25.20 ± 5.37	1.000	0.330

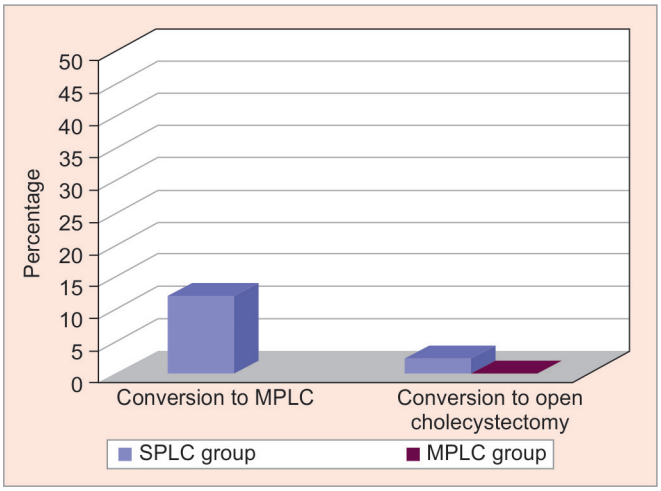


Fig. 4: Conversion to MPLC in SPLC group

Port-site incisional hernia: In the SPLC group, port-site incisional hernia developed in two patients whereas in the MPLC group no patient developed port-site incisional hernia within the six-month follow-up period ($p = 0.147$). Two patients had port-site incisional hernia within the first six months postoperatively (Table 5), so patients should be informed to avoid heavy exertion and exercises during the first three months postoperatively.

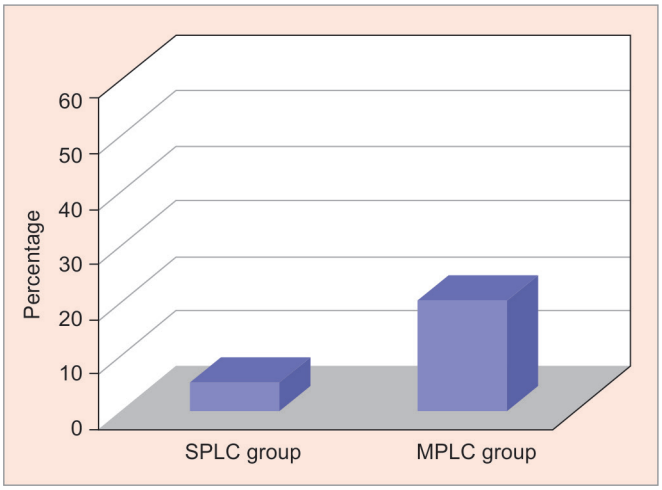
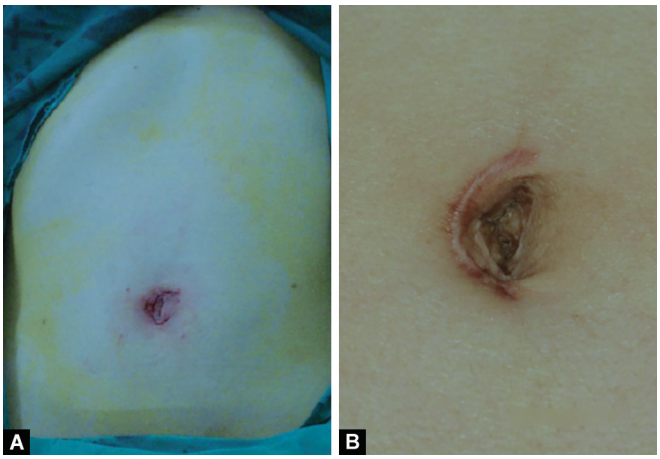


Fig. 5: Postoperative wound infection in SPLC and MPLC groups

Table 5: Incidence of postoperative port-site incisional hernia in both groups

	SPLC group (n = 40)		*MPLC group (n = 40)*			
	No.	*%*	*No.*	*%*	X^2	*p*
Port-site incisional hernia	2	5%	0	0%	2.105	0.147



Figs 6A and B: (A) The transumbilical incision immediately after surgery; (B) The transumbilical incision 6 months postoperatively

Cosmetic results: Esthetic outcomes were higher in the first group having one incision concealed in the umbilicus rather than having four separate incisions as in the MPLC group (Fig. 6).

Discussion

SILS is one of the most advanced innovation in the field of MIS. The collaboration between the biomedical industry, technology research, and surgical experts is the guiding force to add more patient-friendly techniques to the field of surgery. The target of SILS is to minimize surgical invasiveness of port access and provide surgery with no scar as the slit of port access is most often concealed within the umbilicus.[21–24]

The latest invention in SILS is use of the single-access device. This technique accommodated the introduction of three or four instruments through a single access device via an opening in the umbilicus. The latest devices that are available let the surgeon to insert more than two instruments and an optic with or without trocars through one port. Triangulation can be gained through articulating prebent instruments.[25–28]

We will now discuss the advantages, disadvantages, and difficulties that we faced during our own experience of SPLC at the General Surgery department at Mansoura University Hospital.

A recent revolution in MIS for the majority of surgical specialties has been the rapid recovery times with shorter hospitalization, fewer wound-related complications post-operatively, and better esthetic results. However, MPLC is still associated with more tissue trauma due to the size and number of ports utilized.[18,29–31]

In our study, the postoperative pain in both groups was compared using the number of patients who required additional analgesia for breakthrough pain (NSAIDS). Analysis of these two items showed that postoperative pain was more in the MPLC group. According to Prasad A et al., Group A patients experienced less postoperative pain than those of the other group.[12,32]

SILS is a maneuver to minimize multiple incisions by using a small hidden intraumbilical slit, thereby making SPLC seems like a scarless operation to the candidate.[33–36] According to the patients' own assessment in our study, those who underwent SPLC had better esthetic outcome and more candidate satisfaction than those in the MPLC group.

According to a study, SPLC patients were cosmetically superior than MPLC cases and were also higher in the same group in terms of patient satisfaction scores; thus cases in Group A were more satisfied with the overall outcomes of the technique.[37]

According to a study of SPLC conducted in 107 cases of which 81 (76%) were done successfully, the LoS of the SPLC group vs that for the MPLC group was statistically different. The successful SPLC cases had a mean LoS of 1.1 ± 0.35 days compared with 1.4 ± 1.3 days for the MPLC group.[38] In our current research, the average postoperative LoS for successful SPLC was 24 hours and for the MPLC group (25 ± 5.37 hours) there was insignificant difference between the two groups.

In our study, port-site wound infection occurred in two patients of the SPLC group whereas in the MPLC group it occurred in eight cases. According to Lee et al.'s study, the incidence of postoperative port-site wound infection was less in the SPLC group.[37] In the current research, the average operative time was 100 minutes in the first 10 patients in the SPLC group and it decreased to 80 minutes in the second 10 patients denoting that the operative time reduces with an improved learning curve.

The experience with SPLC is manifest in the cholecystectomy trial of Tacchino et al. as the operative time reduced from 180 minutes for the first patient to 105 minutes for the second patient and remained at an average of 50 minutes finally. Some researchers concluded no learning curve for this technique when transabdominal sutures were used for clear exposure from the start. To enhance the learning curve, laboratory training on dry porcine models was advised.[31]

SPLC is an advanced laparoscopic technique, and it should be done basically by surgeons with enough experience in traditional laparoscopy. Surgeons face a learning curve in using the instruments with a limited range of motion. The operators also are in need of frequent adjustment of the vision due to simultaneous movement of both the laparoscope and instruments. This mandates skilled laparoscopists with superior coordination and harmony between the surgeon and the assistant, which increases with experience.[31,34–36,39]

SPLC can be done safely with standard straight laparoscopic instruments. In our study 10 patients out of 40 were operated by the standard laparoscopic instruments and all were completed successfully. According to Cantore et al.'s study of 20 candidates (16 women, 4 men) of SILC, 4 (20%) had had previous abdominal surgery (appendectomy in all patients). Traditional straight laparoscopic instruments were used. All patients were successfully operated without additional skin slits. This study concluded that SILC with traditional straight laparoscopic instruments is feasible and safe.[40]

In recent years, SILS and NOTES have received attention for both clinical and industrial aspects. The key advantages in favor of these two techniques are the esthetic outcome, fast recovery of patients, and reduced need for analgesia.[18–20] SILS is considered superior to other NOTES because it does not involve manipulation of instruments through internal hollow organs such as the stomach or vagina.[31,32,37]

In our present research, the mean operative time in the first group as a new procedure was 95.75 minutes, which was significantly higher than in the MPLC group (42.10 minutes). According to one research, which was carried out on 60 patients divided into two equal groups of 30 candidates each, Group I was offered MPLC and in Group II, SILC was done. Length of stay, pain score, operative time, and wound infection rates were compared between the two groups. Operative times in Group I and Group II were 38.50 ± 8.92 minutes and 80.17 ± 30.16 minutes, respectively. p value was 0.0001, which indicates an important difference between the two groups.[41]

As the number of cases undergoing SPLC increased, there was an important reduction in the operative time with improvement of the learning curve. In our current study, operative time after first 20 SPLC techniques showed a significant reduction. This correlates with the recorded "learning curve" in other research studies.[24]

In one study, the postoperative incidence of port-site incisional hernia in the 1st group was higher postoperatively (2 cases out of 20). An issue that many operators expressed about SILS is the probability of a high occurrence of port-site incisional umbilical hernias postoperatively. The concern behind this query was that SILS requires a bigger fascial incision (20–30 mm) to accept a multichannel port device. So careful closure of the fascial defect and postoperative instructions to avoid heavy work and exercises within the first three months post-operatively are obligatory.[24,39,42]

In our study, the instrumental cost of the SPLC using a commercial port and curved instruments was significantly higher than the cost for MPLC. According to a previous experience, two consecutive series of cases with SILC were assessed and revealed that the instrumental cost of SILC using a commercial port was significantly higher (median $1123) than the cost for MPLC (median $441, $p = 0005$).[43] SPLC has secondary advantages including improved esthetic outcomes, LoS, and a rapid return to work Therefore, the cost of the SPLC procedure should not be the reason to reject the technique.

Major technical difficulties with this novel procedure are the sacrifice that have to be made in terms of ergonomics and comfort. Because all camera and instruments are accommodated through the same slit, the triangulation of instruments around the target was lost. In our current research, this resulted in an initial significant increase in the operative time. However, in our study with an improvement of the learning curve of the technique, operative times have been minimized significantly and are now very near to the mean time taken for traditional laparoscopy. Future technical improvements in instrumental technology may guide minimizing of the operative times further.[41,43,44]

Another issue that must be understood with SILS is cross-handedness. Early in our current study, we struggled with hand placement outside the abdomen as the sphere of space that the external components of the instrumentation and the surgeons' hands inhabit is decidedly smaller.[45,46]

In general aspects, case results and safety from any operative technique may be affected by three various, but equally significant, items: the patients' health (or disease); surgeons (expertise, training, and his/her surgical team); and technology used.[47] In our current research, simple cases with straightforward diseases are the most proper cases for this procedure. Thus, one might think that patients who are morbidly obese, those with previous abdominal surgeries (especially ventral hernia repairs with mesh), very tall candidates, or cases with multiple comorbidities may be excluded (at least at an early time of experience with an operator's single-port use).

In general, all periprocedural complications linked to laparoscopy will also be potential concerns in SILS. At present, most clinical research studies have not reported a higher complication rate, or more serious entities of complications, after SILS. In fact, the available experience has revealed the same results with SILS as compared to conventional laparoscopic approach, with the addition of many of its proposed and unique benefits, such as improved esthetic outcomes from virtually hidden scars.[45,46]

There may be a subset of potential complications, which may prove to be more common with SILS as compared with other traditional procedures. Of particular concern is that electrical injuries could be more prone to occur, at least in theory. These may occur as a result of the near proximity of laparoscopic instruments, with close contact, to each other. However, it did not occur in our study.[46]

Conclusion

SILS allowed for better cosmesis, less pain and faster recovery, less wound infections, ease of tissue retrieval, combination procedure, and patient acceptance. Standard instruments can be used, and natural orifices need not be violated. SPLC can be done safely with standard straight laparoscopic instruments. With improvement of the learning curve of the technique, operative times have been minimized significantly.

Orcid

Selmy Mohamed Awad https://orcid.org/0000-0002-2724-5599

References

1. Reynolds W Jr. The First Laparoscopic Cholecystectomy. JSLS 2001;5(1):89–94. PMID: 11304004.
2. Mühe E. Long-term Follow-Up After Laparoscopic Cholecystectomy. Endoscopy 1992;24(9):754–758. PMID: 1468391.
3. Vemulapalli P, Agaba EA, Camacho D. Single Incision Laparoscopic Cholecystectomy: A Single Center Experience. Int J Surg 2011;9(5): 410–413. PMID: 21515426.
4. Kimura T, Sakuramachi S, Yoshida M, et al. Laparoscopic Cholecystectomy Using Fine-Caliber Instruments. Surg Endosc 1998;12(3):283–286. PMID: 9502715.
5. Mrksić MB, Farkas E, Cabafi Z, et al. Komplikacije laparoskopske holecistektomije [Complications in laparoscopic cholecystectomy]. Med Pregl 1999;52(6–8):253–257. PMID: 10518382.

6. Hugh TB, Kelly MD, Mekisic A. Rouvière's Sulcus: A Useful Landmark in Laparoscopic Cholecystectomy. Br J Surg 1997;84(9):1253–1254. PMID: 9313706.
7. Xu F, Xu CG, Xu DZ. A New Method of Preventing Bile Duct Injury in Laparoscopic Cholecystectomy. World J Gastroenterol 2004;10(19):2916–2918. PMID: 15334701.
8. Way LW, Stewart L, Gantert W, et al. Causes and Prevention of Laparoscopic Bile Duct Injuries: Analysis of 252 Cases from a Human Factors and Cognitive Psychology Perspective. Ann Surg 2003;237(4):460–469. PMID: 12677139.
9. Hugh TB. New Strategies to Prevent Laparoscopic Bile Duct Injury—Surgeons Can Learn from Pilots. Surgery 2002;132(5):826–835. PMID: 12464867.
10. Riall TS, Zhang D, Townsend CM Jr, et al. Failure to Perform Cholecystectomy for Acute Cholecystitis in Elderly Patients is Associated with Increased Morbidity, Mortality, and Cost. J Am Coll Surg 2010;210(5):668–679. PMID: 20421027.
11. Mittermair C, Schirnhofer J, Brunner E, et al. Single Port Laparoscopy in Gastroenterology and Hepatology: A Fine Step Forward. World J Gastroenterol 2014;20(42):15599–15607. PMID: 25400443
12. Katkhouda N. Single Access Laparoscopic Surgery (SALS). In: Katkhouda Namir Advanced Laparoscopic surgery: Technique and tips. 2nd ed. Los Angeles, CA: Springer Science+Business Media. 2010; P257–63.
13. Hirano Y, Watanabe T, Uchida T, et al. Single-incision Laparoscopic Cholecystectomy: Single Institution Experience and Literature Review. World J Gastroenterol 2010;16(2):270–274. PMID: 20066749.
14. Rane A, Dasgupta P. Single-incision Laparoscopic Surgery. BJU Int 2009;103(4):429–30. PMID: 18778354.
15. Piskun G, Rajpal S. Transumbilical Laparoscopic Cholecystectomy Utilizes No Incisions Outside the Umbilicus. J Laparoendosc Adv Surg Tech A 1999;9(4):361–364. PMID: 10488834.
16. Strasberg SM, Hertl M, Soper NJ. An Analysis of the Problem of Biliary Injury During Laparoscopic Cholecystectomy. J Am Coll Surg 1995;180(1):101–125. PMID: 8000648.
17. Adams DB. The Importance of Extrahepatic Biliary Anatomy in Preventing Complications at Laparoscopic Cholecystectomy. Surg Clin North Am 1993;73(4):861–871. PMID: 8378825.
18. Antonio M Lacy, Homero R, Salivadora D. Colorectal surgery. In: Assalia A, Gagner M, Schein M Controversies in Laparoscopic surgery. New York: Springer Science+Business media Inc 2006: p. 361–79.
19. Federico A, Assalia A , Gagner M. Pancreatic surgery. In: Assalia A, Gagner M , Schein M. Controversies in Laparoscopic surgery. New York, USA: Springer Science+Business Media Inc 2006: p. 345–P356.
20. Gkegkes ID, Mourtarakos S, Iavazzo C. Single-incision Laparoscopic Splenectomy. JSLS 2014;18(3):e2014.00350. PMID: 25392670.
21. Steiner CA, Bass EB, Talamini MA, et al. Surgical Rates and Operative Mortality for Open and Laparoscopic Cholecystectomy in Maryland. N Engl J Med 1994;330(6):403–408. PMID: 8284007.
22. Ou ZB, Li SW, Liu CA, et al. Prevention of common bile duct injury during laparoscopic cholecystectomy. Hepatobiliary Pancreat Dis Int 2009;8(4):414–417. PMID: 19666412.
23. Najmaldin A, Guillou P. A Guide to Laparoscopic surgery. New Jersey: Wiley-Blackwell 1998: p. 7–14.
24. Sharma A, Soni V, Baijal M, et al. Single Port Versus Multiple Port Laparoscopic Cholecystectomy—A Comparative Study. Indian J Surg 2013;75(2):115–122. PMID: 24426405.
25. James A Dickerson II, Chan W Park , Aurora D Pryor. Single-Site Access Surgery. In: Nathaniel J. Soper, Carol E.H. Scott-Conner the SAGES Manual Volume 1 Basic Laparoscopy and Endoscopy. London: Springer Science+Business Media, LLC. 2012: p. 87–98.
26. Litwin DE, Cahan MA. Laparoscopic Cholecystectomy. Surg Clin North Am 2008;88(6):1295–ix. PMID: 18992596.
27. Carbonell AM 2nd. Minimally Invasive Gastric Surgery. Surg Clin North Am 2011;91(5):1089–1103. PMID: 21889031.
28. Rao PP, Rao PP, Bhagwat S. Single-incision Laparoscopic Surgery—Current Status and Controversies. J Minim Access Surg 2011;7(1):6–16. PMID: 21197236.
29. Jeffrey W Milsom, Bartholomaus Bohm, Kiyokazu Nakajima. Small bowel resection. In: Jeffrey W. Milsom, Bartholomaus Bohm, Kiyokazu Nakajima Laparoscopic Colorectal surgery. 2nd ed. New York: Springer Science+Business media Inc 2006: p. 111–118.
30. Mostaedi R, Milosevic Z, Han HS, et al. Laparoscopic Liver Resection: Current Role and Limitations. World J Gastrointest Oncol 2012;4(8):187–192. PMID: 22912914.
31. Ahmed K, Wang TT, Patel VM, et al. The Role of Single-Incision Laparoscopic Surgery in Abdominal and Pelvic Surgery: A Systematic Review. Surg Endosc 2011;25(2):378–396. PMID: 20623239.
32. Prasad A, Mukherjee KA, Kaul S, et al. Postoperative Pain after Cholecystectomy: Conventional Laparoscopy Versus Single-Incision Laparoscopic Surgery. J Minim Access Surg 2011;7(1):24–27. PMID: 21197238.
33. Merchant AM, Cook MW, White BC, et al. Transumbilical Gelport Access Technique for Performing Single Incision Laparoscopic Surgery (SILS). J Gastrointest Surg 2009;13(1):159–62. PMID: 18972166.
34. Raj K Goel, Jihad H Kaouk. Difficulties in Single-Port Laparoscopic Procedures. In: Ahmed Al-Kandari.and Inderbir S. Gill Difficult Conditions in Laparoscopic Urologic Surgery. London: Springer-Verlag London Limited 2011: p. 395–404.
35. Benhidjeb T, Stark M, Jakob R, et al. Single-access surgery: less is more? In: Andrea Tinelli, Ed. Laparoscopic entry. London: Springer-Verlag 2012: p. 133–160.
36. Froghi F, Sodergren MH, Darzi A, et al. Single-incision Laparoscopic Surgery (SILS) in General Surgery: A Review of Current Practice. Surg Laparosc Endosc Percutan Tech 2010;20(4):191–204. PMID: 20729685.
37. Broeders IA. Randomized Clinical Trial of Single-Incision Laparoscopic Cholecystectomy Versus Minilaparoscopic Cholecystectomy (Br J Surg 2010;97:1007–1012). Br J Surg 2010;97(7):1012. PMID: 20632265
38. Khambaty F, Brody F, Vaziri K, et al. Laparoscopic versus Single-Incision Cholecystectomy. World J Surg 2011;35(5):967–972. PMID: 21359686.
39. Autorino R, Cadeddu JA, Desai MM, et al. Laparoendoscopic Single-site and Natural Orifice Transluminal Endoscopic Surgery in Urology: A Critical Analysis of the Literature. Eur Urol 2011;59(1):26–45. PMID: 20828918.
40. Cantore F, Colombo EM, Giuseppe MD, et al. Single Access Cholecystectomy Using Standard Laparoscopic Instruments. Updates Surg 2011;63(1):31–34. PMID: 21267691.
41. Culp BL, Cedillo VE, Arnold DT. Single-incision Laparoscopic Cholecystectomy Versus Traditional Four-Port Cholecystectomy. Proc (Bayl Univ Med Cent) 2012;25(4):319–323. PMID: 23077377.
42. Agaba EA, Rainville H, Ikedilo O, et al. Incidence of Port-Site Incisional Hernia After Single-Incision Laparoscopic Surgery. JSLS 2014;18(2):204–210. PMID: 24960483.
43. Henriksen NA, Al-Tayar H, Rosenberg J, et al. Cost assessment of Instruments for Single-Incision Laparoscopic Cholecystectomy. JSLS 2012;16(3):353–359. PMID: 23318059.
44. Lewis T, Aggarwal R, Kwasnicki R, et al. Does Previous Laparoscopic Experience Improve Ability to Perform Single-Incision Laparoscopic Surgery? Surg Endosc 2012;26(5):1214–1219. PMID: 22179448.
45. Romanelli JR, Roshek TB 3rd, Lynn DC, et al. Single-port Laparoscopic Cholecystectomy: Initial Experience. Surg Endosc 2010;24(6):1374–1379. PMID: 20039073.
46. Homero Rivas. Complications in single-incision laparoscopic surgery. In: David S. Tichansky, John Morton, Daniel B. Jones, Eds. The SAGES manual of quality, outcomes and patient safety. : Springer. 2012;p. 347–54.
47. Gunaratnam C, Bernstein M. Factors Affecting Surgical Decision-Making-A Qualitative Study. Rambam Maimonides Med J 2018 29;9(1):e0003. PMID: 29406843.