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Single incision laparoscopic abdominal surgeries: case series of 155 various procedures, an observational cohort study

Enver Özkurt[1], Umut Barbaros[2], Nihat Aksakal[2], Selim Doğan[3], Alp Bozbora[2]

[1] Department of General Surgery, Dana Farber Cancer Institute Harvard Medical School, Boston, United States
[2] Department of General Surgery, Istanbul University Faculty of Medicine, Istanbul University, İstanbul, Turkey
[3] Department of General Surgery, Istanbul Training and Research Hospital, İstanbul, Turkey

ABSTRACT

Objective: Over the last decade, surgeons have started to think of the ways in which to further reduce the trauma of surgery and improve cosmesis. Consequently, many surgeons have yielded to single incision laparoscopic surgeries (SILS) in order to maximize operative and postoperative outcomes. This study aimed to highlight the feasibility and challenges of different procedures by presenting our data about different fields of abdominal SILS practices with long term follow-up.

Material and Methods: We retrospectively analysed an observational cohort of 155 patients who underwent surgery for different indications using the SILS technique.

Results: Of the 155 SILS procedures: 75 (48.4%) were cholecystectomies; 22 (14.2%) were splenectomies; 17 (11%) were hernia repairs; 11 (7.1%) were appendectomies; 8 (5.2%) were partial colon resections; 8 (5.2%) were adrenalectomies; 6 (3.8%) were distal pancreatectomy & splenectomies; 3 (1.9%) were subtotal gastrectomies; 3 (1.9%) were partial liver resections; and 2 (1.3%) were Nissen fundoplications. Ten (6.5%) early and 3 (1.9%) late postoperative complications were detected. No mortality or late morbidity (> 30 days) was detected due to SILS procedures.

Conclusion: SILS is a feasible technique in experienced hands for specific procedures. Meticulous patient selection is also important for good cosmetic results and outcomes.

Keywords: Appendectomy, cholecystectomy, laparoscopic surgery, laparoscopy, single incision, splenectomy

INTRODUCTION

Starting in the nineteenth century (the golden era), surgery began to evolve from radical surgical procedures to minimally invasive procedures. K. Semm described the first laparoscopic appendectomy in 1983 (1-3), and it was followed by the first laparoscopic cholecystectomy in 1985 (4). These procedures are currently the gold standard approaches since they provide better cosmetic results; less postoperative pain; shorter hospital stay; and faster recovery. In addition, laparoscopy has also been a standard in various different surgeries such as: colorectal surgery; splenic surgery; urinary surgery; and lung surgery. In the last decade, surgeons have started to suggest different approaches to further reduce the trauma of surgery using natural orifices (invisible scars) and improve cosmesis (5). However, that was not feasible due to the lack of the instrumental and technological innovations until recent years. Therefore, many surgeons in this field turned their attention to single incision laparoscopic surgeries (SILS), which is a principal first-step for natural orifice surgery (NOS). The ulterior motive of effort was further maximizing cosmetic results; the operative and postoperative outcomes; and patient comfort. In this observational cohort study, it was aimed to present our SILS series in different fields of abdominal surgical practice with long term follow-up and to highlight the feasibility of different procedures.

MATERIAL and METHODS

We retrospectively evaluated an observational cohort of 155 patients who underwent SILS between January 2009 and December 2012 in our clinic for different diagnoses. Demographic data, perioperative data (indications for surgery, sur-

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Corresponding Author
Enver Özkurt
E-mail: doctorenver@gmail.com

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gery type, blood loss, conversion to open or conventional laparoscopic surgery) and postoperative data (early postoperative complication, late postoperative complication and length of hospital stays) were all prospectively recorded in a chart specifically designed for SILS cases. Patients' exclusion criteria for SILS procedure were previous abdominal surgery, patients with an ASA grade IV and V classification, patients with a contraindication for laparoscopic surgery depending on the procedure (i.e., oversized spleens, perforated appendicitis), and age>70.

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. The study was approved by the local ethical committee of the home institution.

All procedures were performed by the same surgeon who is an expert in laparoscopic surgery over 10 years and specifically in SILS surgery for 5 years. The surgeon performs around 250-300 laparoscopic surgeries (both CL and SILS) a year with different indications.

All patients who underwent splenectomy were vaccinated with Pneumovax 23 (Merck & Co., Inc., Whitehouse Station, New Jersey, United States) two weeks prior to surgery, and a prophylactic antibiotic was administered (1g intravenous ampicillin-sulbactam) before surgery. An intravenous contrast enhanced abdominal multislice computed tomography scan was performed to measure the pre-operative splenic dimensions and to search for susceptible accessory spleens. Adrenalectomy candidates were discussed in a multidisciplinary meeting by the surgeons and the endocrinologists prior to surgery. All surgical procedures, other than retroperitoneal adrenalectomies, were carried out with access through the umbilicus using the SILS port and articulated devices specifically designed for SILS surgery. Conversion was defined as either conversion to conventional laparoscopy (CL) or open surgery. Early postoperative complication was defined as a possible minor or major complication that occurred until the end of the postoperative day two (within 48 hours after surgery). Late postoperative complication was defined as any possible minor or major complication developing between postoperative day three and day thirty. Late complication was defined as any possible minor or major complication developing after postoperative day thirty.

Statistical Analysis

Categorical and continuous variables were summarized using descriptive statistics like mean and median, range, frequency, and percentage. Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 24 (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp., United States).

RESULTS

Of the 155 SILS procedures: 75 (48.4%) were cholecystectomy; 22 (14.2%) were splenectomy; 17 (11%) were hernia repair; 11 (7.1%) were appendectomy; 8 (5.2%) were partial colon resection; 8 (5.2%) were adrenalectomy; 6 (3.8%) were distal pancreatectomy & splenectomy; 3 (1.9%) were subtotal gastrectomy; 3 (1.9%) were partial liver resection; and 2 (1.3%) were Nissen fundoplication. The demographic and surgical data of the patients is presented in the table. Operative blood loss was negligible (less than 20 mL) in cholecystectomy; hernia repair; appendectomy; partial colon resection; and Nissen fundoplication group. There was only one conversion to laparotomy in the splenectomy group due to splenic artery haemorrhage which resulted from a malfunctioning vascular stapler. We reasoned that this was because of the thick fat pad around the splenic hilum where the stapler was applied. The patient was administered two units of erythrocyte suspension. A total of 10 (6.5%) early postoperative complications were detected. Only one was a severe complication that was detected in a patient with immune thrombocytopenic purpura who underwent splenectomy. During the first twenty-four hours, the patient was hypotensive, tachycardic, and a rapid decline was detected in the haemoglobin and haematocrit levels. The patient was re-operated on under laparotomy and resultant bleeding due to iatrogenic parenchymal lacerations was put under control. One patient with a cystic stump leak after cholecystectomy was managed conservatively with drainage. No major late postoperative complications were detected; however, port site hernias were detected in 3 (1.9%) patients. Low-level drain amylase elevation occurred in 6 of our patients, of whom 3 were in the pancreatectomy group. These patients were observed by following the daily drain level and the drain amylase level. All surgical drains were removed within two weeks when pancreatic drain level was detected below 50mL and the amylase level was normal. Median follow-up time was 8 years. There was only one mortality and no late morbidity (late incisional hernias, adhesion ileus, re-operation for recurrent disease or any cause related to initial operation).

DISCUSSION

Over the last four decades, surgeons have sought less invasive procedures and been more sensitive regarding human anatomy. Laparoscopic surgery concept which started in the early 1980s also aimed for better cosmesis, less pain, faster postoperative recovery, and less trauma to the patient by achieving similar oncologic and surgical results. Therefore, the current laparoscopic surgical procedures are the gold standard in many surgical fields. The number of less invasive methods has rapidly increased over the last decade. The goal is to achieve surgical procedures which are ultimately scar-free. Early experimental attempts of NOS encountered some limitations and disadvantages (6). The instruments specifically designed for NOS are vital, as the tools used in

Table 1. Demographic, perioperative, and postoperative features of the SILS patients cohort

Age (Median)	Sex (M/F)	Operation Type	Indication	Operation Time (min)	Blood Loss (ml)	Conversion	Early PO Complication	Late PO Complication	LoHS (day)
45 (19-70)	35/40	Cholecystectomy	Gallstones (n= 73)	50.7 ± 14.7 (SD)	0	No	Cystic stump leak (n= 1)	Port site hernia (n=1)	1 ± 0.2 (SD)
			Gallbladder Polyp (n= 2)						
32.5 (18-57)	6/16	Splenectomy	ITP (n= 21)	68.4 ± 29.5 (SD)	80 ± 135.5 (SD)	Yes (n= 1)	LL-DAE (n= 1)	No	2.4 ± 1.3 (SD)
			Wandering Spleen (n= 1)				Arterial haemorrhage (n= 1)		
38 (23-70)	13/4	Hernia Repair	Inguinal Hernia (n= 12)	46.6 ± 15.5 (SD)	0	No	No	No	1
			Umbilical Hernia (n= 3)						
			Incisional Hernia (n= 2)						
33 (19-56)	6/5	Appendectomy	Acute Appendicitis (n= 11)	37.2 ± 9.4 (SD)	0	No	No	Port site hernia (n= 1)	1
50 (39-65)	4/4	Partial Colon Resection	Sigmoid Colon Tumor (n= 6)	93.7 ± 16.9 (SD)	0	No	No	No	6.2 ± 1 (SD)
			Right Colon Tumor (n= 1)						
			Rectosigmoid Tumor (n= 1)						
43.5 (35-55)	3/5	Adrenalectomy	(TP) Conn Syndrome (n= 1)	71.2 ± 15.1 (SD)	36.2 ± 10.6 (SD)	No	LL-DAE (n= 1)	No	4.2 ± 1.7 (SD)
			(TP) Adrenal Carcinoma (n= 1)						
			(RP) Cushing (n= 2)						
			(RP) Non-functional Adenoma (n= 2)						
			(RP) Metastatic Adrenal Carcinoma (n= 1)				Port site infection (n= 1)		
			(RP) Pheochromocytoma (n= 1)						
52.5 (41-60)	3/3	Distal Pancreatectomy & Splenectomy	Insulinoma (n= 2)	298.3 ± 22.3 (SD)	75 ± 18.7 (SD)	No	LL-DAE (n= 3)	No	3.3 ± 1.4 (SD)
			Pancreas Adenocancer (n= 1)						
			Neuroendocrine Tumor (n= 1)						
			Renal Cell Cancer Metastasis (n= 1)				Gastric atonia (n= 1)		
			Pancreas Pseudocyst (n= 1)						
52 (43-58)	2/1	Subtotal Gastrectomy	Gastric Cancer (n= 3)	245 ± 65 (SD)	170 ± 131.1 (SD)	No	LL-DAE (n= 1)	Port site hernia (n= 1)	5.3 ± 0.7 (SD)
49 (44-57)	2/1	Partial Liver Resection	Hemangioma (n= 2)	125 ± 18 (SD)	116.7 ± 76.4 (SD)	No	No	No	3
			Hepatic Adenoma (n= 1)						
49.5 (37-62)	1/1	Nissen Fundoplication	Hiatal Hernia (n= 2)	110 ± 14.1 (SD)	0	No	No	No	1

*Age was presented as median. Operation time (minutes), intraoperative blood loss (millilitres), and length of hospital stay (days) were presented as mean with standard deviations.
M: Male, F: Female, PO: Post-operative, LoHS: Length of Hospital Stay, SD: Standard Deviation, ITP: Immune Thrombocytopenic Purpura, LL-DAE: Low Level Drain Amylase Elevation, TP: Trans-peritoneal, RP: Retro-peritoneal.

routine practices have limited range of motion inside the abdomen. Contamination and viscerotomy closure are other major concerns. Therefore, surgeons have stepped back and started to perform surgeries using another less invasive method; SILS.

Single incision laparoscopic surgery was proven to be as feasible as CL surgeries in many different fields of surgical practice (7-17). The most significant advantages of SILS are better cosmesis, less pain, and faster recovery (7,9,12). Our series of SILS cases also present shorter hospital stays especially for the major abdominal surgeries such as splenectomies, colon resections, pancreatico-splenectomies, subtotal gastrectomies, and partial liver resections.

SILS appendectomies are the practice-procedures of single incision surgeries. The learning curve is fast, easy, and beneficial when considering engaging with more complex procedures. In a meta-analysis that included 1.489 patients from eleven randomized controlled trials comparing SILS appendectomy with CL appendectomy (13), the authors suggest that SILS patients have significantly shorter hospital stay (p= 0.003) and return to activity faster (p= 0.002). However, they experienced a longer operating time (p< 0.0001) and a higher rate of conversion (p< 0.00001). There were no differences in visual analogue pain scores, overall complication rates, and cosmesis. Only one late postoperative complication of a port site hernia from umbilical access was detected in our series of 11 SILS appendectomies.

Cholecystectomies are one of the most frequently performed procedures using the SILS method. A clinical comparative study of SILS and CL cholecystectomies in Turkey and Spain (9) has shown that the rates of satisfaction and aesthetic results are significantly higher for SILS patients with other similar perioperative outcomes. This study has stressed that conversion to CL surgery should be performed when there are doubts over safety. Haueter R. et al. conducted a literature search for randomized controlled trials comparing SILS and CL cholecystectomies including thirty-seven studies with 3,051 patients (11). The meta-analysis revealed that body image scores, cosmesis scores and wound satisfaction scores were more favourable for SILS at all time points (short-term, mid-term, long-term). Postoperative pain was lower at the twelfth hour (p= 0.007.) Duration of surgery was longer for SILS (mean difference 13.56 min: p< 0.001) and SILS required more additional ports (odds ratio 6.78: p< 0.001). But most of all, incisional hernia rate was higher after SILS (4% for SILS and 1.1% for CL; OR 2.50, p= 0.03.) We only have one (1.3%) port site hernia in seventy-five SILS cholecystectomies which is a comparable rate with CL procedures. Meticulous anatomical closure is probably the most important fact at this point. Studies showed that bile duct injury rate was 0.7%, and 0.5% for SILS and CL techniques respectively. Although no bile duct injury was detected, we found a low-level cystic stump leak in one patient on postoperative day two, and the patient was followed up conservatively. Serous drainage was detected on postoperative day seven, and the drain was thus removed. The possible cause of cystic stump leak may be the oedema and the elevation of the intraductal biliary fluid pressure caused by surgical trauma around the biliary tract after cystic duct.

Barbaros et al. have reported the first SILS splenectomy (18). Since then, we have conducted twenty-one splenectomies. Indication for surgery was the immune thrombocytopenic purpura for all patients other than one patient with wandering spleen syndrome. It should be kept in mind that the procedure is ideal for normal- to mid-sized spleens, and not suitable for haematological malignancies. Barbaros et al. (8) have compared the outcomes of the single port and three port laparoscopic splenectomies in another study. Visual analogue pain scores were better ($p < 0.05$); however, surgery time was longer (112 ± 14 minutes for SILS vs. 71 ± 18 minutes for CL; $p < 0.05$) for the SILS group (8).

Hernia repair using SILS is also feasible. However, it provides no additional advantage in comparison with the CL procedure. Shanshan Luo et al. showed in their meta-analysis that SILS approach had similar outcomes with significantly longer operative time (14).

We performed eight partial colon resections using SILS port with no early or late complications. Six were for a sigmoid colon tumor, one for a right colon tumor, and one was for a rectosigmoid tumor. Recently, three meta-analyses presenting outcomes of SILS compared to CL surgery for colorectal disease have highlighted the same results (15-17) SILS cases had significantly shorter hospital stay with comparable outcomes to CL in terms of operating time, conversion rate, re-operation rate, postoperative complications, and mortality. Furthermore, pathological and oncological parameters such as the average dissected lymph node and resection margins were similar (15-16). There was no recurrence or mortality during the median follow-up of 8-years.

Adrenalectomy is also another field of SILS procedure. Although the adrenal gland is a small organ, it is located in the retroperitoneal region neighboured by important anatomical structures, which makes this procedure notably challenging. Retraction of the surrounding organs such as the liver is often challenging. We performed two transperitoneal, and six retroperitoneal adrenalectomies due to different indications. Only two minor complications were detected, one of which was a port site hernia and the other was a low-level of elevation in drain amylase which was hence normalized one week after surgery.

Advanced procedures like pancreatico-splenectomy for pancreatic cancer, gastrectomy for gastric cancer, and partial liver resection for hepatic cancer can be carried out using SILS (10). Besides, surgeons must consider their own knowledge and ex-

pertise in these fields even with open or CL techniques prior to performing these procedures with the SILS technique. Yet, it is still not preferred due a plethora of challenges which include oncological safety concerns. We found no major complications in patients who underwent pancreatico-splenectomy (n= 6), subtotal gastrectomy (n= 3), and partial liver resection (n= 3) surgeries. There was only 1 mortality in a subtotal gastrectomy patient. The patient admitted to clinic with pleural effusion, respiratory distress and stage IV disease in his 4-year follow-up. Careful patient selection is of central importance.

Cosmesis is the most commonly highlighted advantage of SILS. We previously reported better cosmesis and higher rates of satisfaction with SILS technique compared with CL (9). Evans L. and Manley K. have reported that SILS demonstrates a clear advantage in terms of the cosmetic outcome when compared with CL in their systematic review and meta-analysis (12). They have also emphasized that this is a quantifiable advantage as all studies included in the meta-analysis used a specific type of cosmetic/satisfaction scores. There are debates on cosmesis specifically for procedures like colon or liver resections when we need to enlarge or make another incision in order to retrieve the specimen. So, there is uncertainty as to whether it is a SILS procedure anymore. In addition, the evaluation of long-term cosmesis showed that it is significantly affected by port-site hernias. Significantly higher rates of port-site hernias have been reported (odds ratio 2.5; p= 0.03) in SILS compared with CL procedures (11,12,15).

As reported in earlier studies, SILS presents technical difficulties when performing the procedure (7,8,10). Namely because this procedure is performed via a single port that all instruments supported by the same fulcrum, the clashing of instruments inside or outside the surgical area is of concern. Even though there are different angled or articulated instruments on the market to solve this problem, it is still a hassle as many of the meta-analyses reported significantly longer operative times with SILS. Another factor that affects the learning curve of the surgeons is adapting to the use of their cross-hand for the procedures. Right hand for left side, and vice-versa for manipulation, dissection, and traction. More practice is the key at this point. Another concern is the visual area of the surgical field. It is less of an issue for small field surgeries like appendectomies or cholecystectomies. However, things get more complex in colon resections (especially wide segmental resections for transverse colon) because these procedures need to be performed in different regions of the intra-abdominal cavity. The traction of the surrounding tissues and organs is also a concern. Different methods such as suturing the tissue to abdominal wall, puppeting with the sutures, metallic or magnetic clips to fix the structures to the abdominal wall, and rubber bands to hang the structures for different procedures were described so far (7-10). All these methods work for a variety of surgeries. Therefore, in any case, surgeons must be creative to solve the traction problem intraoperatively depending on the circumstances.

There are some limitations of our study. First, this is an observational cohort study with different varieties of surgical procedures. It should be better to compare one kind SILS operation with CL. However, we published our SILS cholecystectomy series and SIL splenectomy series compared with our CL series before. Therefore, we wished to present different procedures of SILS cases in order to present feasibility of different operations. Second, it would be better to present data of our case after December 2012. As we plan to do this study as an observational cohort between 2009 and 2012, we did not collect all data of the SILS cases after December 2012. So, we think that it would be better to present long term follow-up of these patients.

CONCLUSION

In conclusion, SILS is a feasible technique in experienced hands. Careful patient selection is also an important factor for comparable cosmetic results and outcomes. Even though SILS is still not widely accepted, it will be used in multifarious fields in the near future. It should be considered as a leap forward towards NOS with the utilization of innovative devices and technologies in laparoscopic surgery.

Ethics Committee Approval: The approval for this study was obtained from Istanbul University School of Medicine Clinical Research Ethics Committee (Decision No: 1744, Date: 26.10.2011).

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ORİJİNAL ÇALIŞMA-ÖZET
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Tek delikten laparoskopik karın cerrahisi: farklı prosedürleri içeren 155 vakalık gözlemsel kohort serisi

Enver Ozkurt[1], Umut Barbaros[2], Nihat Aksakal[2], Selim Doğan[3], Alp Bozbora[2]

[1] Dana Farber Kanser Enstitüsü Harvard Tıp Fakültesi, Genel Cerrahi Anabilim Dalı, Boston, ABD
[2] İstanbul Üniversitesi Tıp Fakültesi, Genel Cerrahi Anabilim Dalı, İstanbul, Türkiye
[3] İstanbul Eğitim ve Araştırma Hastanesi, Genel Cerrahi Kliniği, İstanbul, Türkiye

ÖZET

Giriş ve Amaç: Son 10 yılda cerrahlar, cerrahi travmayı azaltmanın ve kozmetiği arttırmanın yolunu düşünmeye başladılar. Neticede birçok cerrah perioperatif sonuçları iyileştirmek için tek delikten laparoskopik cerrahiye (TDLC) yöneldi. Bu çalışmada farklı tekniklerle yaptığımız TDLC batın ameliyatlarının uygulanabilirliği, uzun dönem takiplerini, tekniğin avantajları ve zorluklarını sunmayı amaçladık.

Gereç ve Yöntem: Ocak 2009-Aralık 2012 arasında farklı endikasyonlarla ameliyat edilen 155 TDLC batın ameliyatının verileri prospektif olarak toplandı ve retrospektif incelendi.

Bulgular: Hastaların ortalama takip süresi 8 yıldı. 155 TDLC'nin 75'i (%48,4) kolesistektomi, 22'si (%14,2) splenektomi, 17'si (%11) herni tamiri, 11'i (%7,1) apendektomi, 8'i (%5,2) parsiyel kolon rezeksiyonu, 8'i (%5,2) adrenalektomi, 6'sı (%3,8) distal pankreatektomi ve splenektomi, 3'ü (%1,9) subtotal gastrektomi, 3'ü (%1,9) parsiyel karaciğer rezeksiyonu ve 2'si (%1,3%) Nissen fundoplikasyonuydu. 10 (%6,5) erken ve 3 (%1,9) geç postoperatif komplikasyon görüldü. Ameliyata bağlı mortalite görülmedi.

Sonuç: TDLC deneyimli ellerde uygulanabilir bir yöntemdir. Dikkatli hasta seçimi iyi cerrahi ve kozmetik sonuçlar için çok önemlidir.

Anahtar Kelimeler: Apendektomi, kolesistektomi, laparoskopik cerrahi, laparoskopi, tek delik, splenektomi

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