Original Article

Analysis of Risk Factors for Conversion of Single Incision Laparoscopic Surgery for Colorectal Disease

Kuen-Lin Wu
Yueh-Ming Lin
Chien-Chang Lu
Division of Colorectal Surgery, Department of Surgery, Kaohsiung Chang-Gung Memorial Hospital and Chang-Gung University College of Medicine, Kaohsiung, Taiwan

Key Words
Single incision laparoscopic surgery;
SILS;
Conversion;
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Purpose. This study is to purpose the risk factors for conversion of single incision laparoscopic surgery (SILS) for colorectal disease.
Methods. Between March 2010 and March 2015, all patients who received single incision laparoscopic colorectal surgery by a single surgeon were retrospectively reviewed. The demographics, operation procedure and perioperative data were all recorded.
Results. 272 patients were enrolled (206 patients in SILS group and 66 patients in conversion group). The two groups did not differ significantly in age, gender, American Society of Anesthesiology (ASA) score and patients who received previous abdominal or pelvic surgery. The average BMI is lower in SILS group. The operation time was longer and more blood loss in conversion group (167.5 vs. 216.7 minutes, $p < 0.001$ and 35 vs. 64 ml, $p = 0.013$, respectively). The average tumor size was almost equal but wound length was slightly longer in conversion group. In surgical procedure, most right hemicolectomies were done with SILS and most low anterior resections were converted to reduced port laparoscopic surgery. In obese patient, 44% of them were converted to reduced port laparoscopic surgery.
Conclusions. Our study demonstrates that middle to low rectal cancer and obesity are the risk factors for conversion of single incision laparoscopic surgery for colorectal disease. Most of these cases can be safely finished after conversion to reduced port laparoscopic surgery with inserting one or two additional ports.
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Minimal invasive surgery is a novel procedure gaining worldwide acceptance. Since 1981 when Tarasconi published his endoscopic salpingectomy procedure, a variety of minimal invasive surgery techniques have been developed and documented in medical literature.[1] In the colorectal field, the first laparoscopic colectomy was performed by Moises Jacobs in 1990.[2] Since then, laparoscopic surgical techniques have advanced and no longer considered as resulting in poor oncologic outcome, being technically demanding, and requiring a long learning curve. Several randomized trials, Cochrane reviews, and meta-analyses have indicated that laparoscopic colorectal surgery is not only safe but is also associated with better short-term outcomes and does not worsen long-term cancer survival.[3-7] However, surgeons are not satisfied

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Correspondence to: Dr. Chien-Chang Lu, Division of Colorectal Surgery, Department of Surgery, Kaohsiung Chang-Gung Memorial Hospital, Kaohsiung 83301, Taiwan. Tel: 0975-056226; E-mail: cclu999@gmail.com

with these minor advantages. The conventional laparoscopic colorectal surgery needs to create a wound that is much bigger than the trocar wound for specimen delivery and causing major postoperative pain. Single-incision laparoscopic surgery (SILS) highlighted this inevitable result and attracted attention during the last decade. Single port trans-umbilical laparoscopy was first announced in 1999. At inception, SILS was applied to adrenalectomy,[8] appendectomy[9,10] and cholecystectomy.[11,12] Previous studies on SILS in the colorectal field were mainly focused on benign colon disease.[13-15] However, series of journal articles on SILS successes in colorectal disease have become preponderant in the past five years with evidence of reduced pain, lower total hospital cost, faster recovery, better cosmesis, and more importantly, reduced potential risks of trocar-related complications such as small bowel injury, vascular injury during trocar insertion, port site herniation, and recurrences; better outcomes than in conventional laparoscopic surgery.[16-18] With selected patients, SILS seems to be feasible and safe in the colorectal disease when it is performed by skilled laparoscopic surgeons. Despite technical difficulties, some potential benefits of SILS over conventional laparoscopic colectomy are unquestionable. Unlike other surgical procedure, SILS for colorectal disease is more difficult because of more extended dissection and operating within a narrow space in low anterior resection. However, few studies discussed the limitation of SILS in the colorectal field, and what patient characteristics is not suitable for SILS, and predispose to high risk of failure. Therefore, we want to analyze those selected patients we supposed that SILS is feasible but subsequent failure. This study aimed to find out the limitation of SILS in the colorectal field, discuss the reason and the conversion method to accomplish operation. Moreover, we want to share our experience for other surgeons who is interested in SILS for colorectal disease.

Materials and Methods

Patients

This study was a single-center study based on a single-surgeon experience. We retrospectively reviewed the medical records and operation notes of all consecutive patients admitted to the division of colorectal surgery, Kaohsiung Chang Gung Memorial hospital between March 2010 and March 2015. All patients underwent elective surgery, received preoperative bowel preparation [using sodium phosphate or polyethylene glycol (PEG)], and received prophylactic antibiotics before skin incision. The inclusion criterion was all patient who consented to SILS approach with appropriate counseling regardless of the potential difficulty, possibility of conversion to reduced port laparoscopic surgery or open surgery. The patient exclusion criterion was SILS assisted natural orifice transluminal endoscopic surgery (NOTES), and SILS without bowel resection, such as enterolysis, stoma creation or repair bowel perforation. Demographic, intraoperative, and postoperative data were all collected, including age, gender, body mass index (BMI), tumor location, operation method, measurable tumor size, length of bowel resection, estimated blood loss, duration of operation time, splenic flexure take-down, drain placement and hospital stay.

Among including cases, some encountered technical difficulties, unexpected adhesion or other problem, and consequently did not accomplish operation via SILS. Unless urgent situation, we usually converted SILS to reduced port laparoscopic surgery, inserted one or two additional ports for assisting, and accomplished operation. We separated collected data into two groups: patients who received SILS and patients who received SILS initially with a conversion to reduced port laparoscopic surgery. We analyzed the two groups to find out the factors predisposing to SILS conversion.

Statistical analysis

All collected data were analyzed using the Chi-square test for categorical values and the independent samples t-test for continuous numerical variables. The statistical results were regarded as significant when the *p*-value was less than 0.05. All statistical analyses were performed with SPSS. (IBM Corp. Released 2013. IBM SPSS Statistics for windows, version 22.0.

Armonk, NY: IBM Corp.)

Results

Patients characteristics

During the study period, 10 conventional multiple ports laparoscopic surgeries, 5 laparoscopic assisted NOTES and 3 SILS converted to open surgeries were excluded. A total of 272 patients (154 men and 118 women) were enrolled in this study. Among them, 206 cases underwent SILS and 66 cases converted to reduced port laparoscopic surgery. The patient demographic data are shown in Table 1. The two groups were comparable in age, sex, American Society of Anesthesiologists (ASA), and patient numbers who had previous abdominal or pelvic surgery. The BMI mean is lower in SILS group (24.0 vs. 25.0 Kg/m^2, p = 0.041).

Intraoperative and perioperative outcomes

Among the SILS group, there were 64 right hemicolectomies, 3 transverse colectomies, 11 left hemicolectomies, 105 high anterior resections, 6 low anterior resections, 16 total colectomies and 1 high anterior resection plus right hemicolectomy. Among the conversion to reduced port group, there were 4 right hemicolectomies, 1 left hemicolectomies, 28 high anterior resections, 30 low anterior resections, 2 total colectomies and 1 high anterior resection plus right hemicolectomy. The operation time was longer and the average amount of blood loss was more in the conversion to reduced port group and was significantly different from the SILS group (167.5 ± 51.5 minutes vs. 216.7 ± 63.0 minutes, p < 0.001 and 31.5 ± 35.5 ml vs. 64 ± 96 ml, p = 0.013, respectively). The average tumor size was similar in both groups (SILS: 3.2 ± 2.0 and conversion to reduced port: 3.1 ± 1.7 cm) but wound length in the conversion to reduced port group was longer (3.8 ± 0.8 cm vs. 4.1 ± 0.9 cm, p = 0.010).

There was no surgical related mortality and within postoperative 30-day death in both groups. The average postoperative hospital stay in the SILS group was 6.9 ± 3.7 days and in the conversion to reduced port group was 8.7 ± 5.7 days. The results are listed in Table 2.

Table 1. Patient demographic data

	SILS (n = 206)	SILS conversion (n = 66)	p value
Age (years)			0.463
Mean	61.2 ± 13.7	62.5 ± 10.6	
Range	18~87	34~82	
Gender n (%)			0.103
Male	111 (54%)	43 (65%)	
Female	95 (46%)	23 (35%)	
BMI (Kg/m^2)			0.041*
Mean	24.0 ± 3.4	25.0 ± 3.9	
Range	15.7~33.8	17.6~36.3	
ASA			.109
I	4 (1.9%)	1 (1.5%)	
II	172 (83.5%)	49 (74.2%)	
III	30 (14.6%)	16 (24.3%)	
Previous abdominal or pelvic surgery history	48 (23.3%)	15 (22.7%)	0.924

SILS: single-incision laparoscopic surgery; BMI: body mass index; ASA: American Society of Anesthesiologists.

Table 2. Intraoperative and perioperative outcomes

	SILS (n = 206)	SILS conversion (n = 66)	p value
Malignancy			0.132
Yes	146 (71%)	53 (80%)	
No	60 (29%)	13 (20%)	
Operation type			
Right hemicolectomy	64	4	
Transverse colectomy	3	0	
Left hemicolectomy	11	1	
Anterior resection	105	28	
Low anterior resection	6	30	
Total colectomy	16	2	
HAR + RH	1	1	
Operation time (mins)	167.5 ± 51.5	216.7 ± 63.0	< 0.001*
Blood loss (ml)	31.5 ± 35.5	60.9 ± 91.4	0.013*
Tumor size (cm)	3.2 ± 2.0	3.1 ± 1.7	0.694
Wound length (cm)	3.8 ± 0.8	4.1 ± 0.9	0.010*
Splenic flexure take down	67	37	
Drain tube placement	73 (35%)	53 (80%)	< 0.001*
Hospital stay (days)			0.015*
Mean	6.9 ± 3.7	8.7 ± 5.7	
Range	3~40	3~43	

HAR: high anterior resection; RH: right hemicolectomy.
* p < 0.05.

Discussion

The single-incision- or single-port laparoscopic surgery has become popular over the past few years. In our department, single incision laparoscopic colectomy is initiated since 2009 and then a self-made glove port system is developed in the next year, which is combination of laparoscopic trocars, surgical glove and commercial wound protector (ALEXIS® Wound Retractor System). A 10 mm 30-degree laparoscope was inserted with 12 mmHg of CO_2 pneumoperitoneum was introdunced.[14] The incision wound is made over the umbilicus or McBurney's point. The glove port system allows a greater range of movement of instruments and more feasibility of direction change than other commercial access system (GelPort® or TriPort®).[19] This is important since the dissection plane in the colorectal field is more extensive than for appendectomy or cholecystectomy. Yet, the disadvantages of SILS still exist and include a loss of triangulation, crowding, collision and interference between the instruments and the laparoscope, and the surgeon's and the camera operator's arms. These interferences usually cause obstruction of the operative fields or increase technical difficulty due to parallel placement of the instruments.[20-22] To overcome these difficulties, steerable endoscopes, bent and articulating instruments, magnetic anchorage and guidance systems have been developed and used. Alternatively, many surgeons choose to performed reduced port laparoscopic surgery and create an additional port to make it easier and reduce economic cost. In the reduced port laparoscopic surgery, through the use of an additional port, parallel placement of the instruments is possible without interference between the camera operator and surgeon's dominant hand, thus providing all of the benefits of conventional laparoscopic surgery,[20] and minimize technical difficulties. The additional port is usually used to place drain after surgery. This technical concept was published as SILS+1[20,23] or umbilical incision laparoscopic colorectal cancer surgery with one additional port (ULAP).[21] In our study design, we separated patients into the SILS group and conversion to reduced port laparoscopic surgery group, instead of SILS+1 because there were 17 cases adding two additional ports. We focused on the predisposing factor leading SILS failure instead of numbers of additional port.

Fung et al. reviews 38 SILS studies in the colorectal field and suggested that surgeons should embark on colonic SILS for patients with no history of inflammatory disease (such as diverticulitis), no previous abdominal or pelvic surgery, and who are not obese (BMI below 30 kg/m^2).[24] Therefore, we employed these patient factors initially and tried to find a significant difference between the two groups. In the operation type, 94% (64/68) of right hemicolectomies were performed via SILS. Among all 36 low anterior resections, there were only 6 cases that were performed via SILS. Tomoki Makino et al. indicated SILS in rectal cancer is more complex and difficult than colonic surgery.[18] This is because while dissecting along rectum in the pelvis, the laparoscope and instruments may impact each other and be inextricable in a narrow space. Besides, the anatomy of rectum and adjacent organs (vagina and uterus in female; prostate in male) make it difficult to dissect rectum toward pelvic floor without another traction by assistant. Moreover, the tip of the laparoscopic stapler (ECHELON FLEX™ ENDOPATH® or Endo GIA™ Curved Tip Reload with Tri-Staple™) is able to bend only up to 45 degrees, which makes it very difficult to transect the low rectum with sufficient distal margins from the umbilical port. Hamzaoglu et al. published one of few studies completed SILS sphincter-saving mesorectal excision[25] but a critical disadvantage of this procedure was the transection of the low rectum with 4 to 6 laparoscopic staplers which may increase the risk of anastomotic leaks.[26] In this situation, we inserted additional port and transected rectum with 1 to 2 staplers. In our SILS LAR cases, the tumor diameter means is smaller than overall rectal tumor size. Orhan Bulut et al. also concluded that SILS is feasible and safe for rectal cancer in non-obese patients with a small tumor when performed by skilled laparoscopic surgeons.[27]

There is no obese patient (BMI > 30.0 kg/m^2) with low rectal cancer in this study. In the colonic setting, the BMI mean in SILS group is significant lower than conversion to reduced port group (24.0 vs. 26.5

kg/m^2, $p < 0.001$). Among the 18 obese patients shown in Table 3, 8 patients (44%) were converted to reduced port laparoscopic surgery. We believe that the surgical landmark is indeed difficult to identify in the obese patient. Moreover, the use of gravity and a tilting operation table to create and maintain the operative field is important in SILS. The interference of the small bowel and mesentery usually occur in an obese patient and maintaining good traction in obese patients is more technically demanding. Thus, obesity is a risk factor for SILS failure. Chen, William Tzu-Liang et al. also indicate that visceral obesity was the primary cause of conversion to open surgery in his experience since identification of the correct surgical plane in patients with visceral obesity was relatively difficult.[28]

In our study, there was only 3 cases (1.1%) where consequently converted to open surgery and the reasons for conversion were locally advanced tumor, bleeding, and severe adhesion resulting from previous abdominal surgery, respectively. The BMI of these 3 patients were 25.8, 22.6 and 21.2 kg/m^2 and none of them had clinical obesity.

There was longer operation time and more blood loss in conversion to reduced port group because higher proportion of obese patient and higher proportion of middle to low rectal cancers which is more difficult and time-consuming procedure.

There were some limitations to this study including its retrospective nature, small sample size, difference in patient numbers between the two groups. Moreover, patients who underwent laparoscopic surgery were highly selected. Consequently, a large prospective investigation is needed to verify our results.

Conclusions

In conclusion, our study demonstrates that middle to low rectal cancer and obesity are the risk factor for conversion of single incision laparoscopic surgery in the colorectal field. Most of these cases can be safely finished after conversion to reduced port laparoscopic surgery with inserting one or two additional ports.

Table 3. Obesity patients

	SILS (n = 206)	SILS conversion (n = 66)	*p* value
BMI ≥ 30 (Kg/m^2)	10 (4.8%)	8 (12.5%)	0.039

BMI: body mass index.

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原　著

分析無法以單孔腹腔鏡完成大腸直腸手術的風險因素

吳昆霖　林岳民　盧建璋

高雄長庚紀念醫院　外科部　大腸直腸肛門外科

目的　評估當使用單孔腹腔鏡來治療大腸直腸疾病時，遭遇到什麼因素將使得手術無法以單孔腹腔鏡完成。

方法　自 2010 年 3 月到 2015 年 3 月間，由同一位外科醫生進行單切口腹腔鏡結直腸手術的患者進行回朔性資料審查。人口統計，手術種類及手術期相關的數據都記錄和分析。

結果　這項研究納入 272 例 (包含 206 例以單孔腹腔鏡完成，66 例術中轉變為減孔式腹腔鏡手術) 的患者。兩組在年齡，性別，麻醉評分和接受過腹部或骨盆腔手術病史的病人數量都沒有顯著差異。病人的平均 BMI 在單孔腹腔鏡組較低。在術中轉變為減孔式腹腔鏡手術這組，有較長的手術時間和較多術中失血。兩組的平均腫瘤大小相近，但額外孔洞組的平均傷口稍長。在手術術式中，右半結腸切除術幾乎都可以經由單孔腹腔鏡完成，而低位前切除術大多都需要打額外孔洞轉變成減孔式腹腔鏡手術。在肥胖的病人當中，有 44% 無法以單孔腹腔鏡完成手術而轉變成減孔式腹腔鏡手術。

結論　我們研究顯示中低位直腸癌及肥胖是大腸直腸手術無法以單孔腹腔鏡完成的風險因素。在這些案例中，絕大多數均可在術中額外增加孔洞轉變為減孔式腹腔鏡手術並安全地完成手術。

關鍵詞　單孔腹腔鏡。