Surg Endosc (2012) 26:96–102
DOI 10.1007/s00464-011-1833-8

Single-incision versus conventional laparoscopic sigmoid colectomy: a case-matched series

Diego I. Ramos-Valadez · Madhu Ragupathi · Javier Nieto · Chirag B. Patel · Steven Miller · T. Bartley Pickron · Eric M. Haas

Received: 13 February 2011 / Accepted: 22 June 2011 / Published online: 27 July 2011

Abstract
Background Single-incision laparoscopic surgery is an emerging modality that has proven to be safe and feasible for colon resection in multiple case reports and series. Nonetheless, comparative analyses with established techniques are limited in the published literature. We evaluated the efficacy of single-incision laparoscopic colectomy (SILC) for the treatment of sigmoid disease through a matched-case comparison with conventional laparoscopic colectomy (CLC).
Methods Twenty patients who underwent single-incision laparoscopic sigmoid resection for benign or malignant disease between July 2009 and September 2010 were matched to patients who underwent conventional laparoscopic sigmoid colectomy. Demographic, intraoperative, and postoperative data were assessed.
Results Twenty SILC and CLC cases each were paired based on gender ($p < 1.0$), age ($p < 0.47$), pathology ($p < 1.0$), and surgical procedure ($p < 1.0$). Ten patients (50%) in the SILC group and eight patients (40%) in the CLC group had a history of prior abdominal surgery ($p < 0.53$). There were no conversions to open surgery; however, one SILC procedure (5%) required conversion to CLC ($p < 0.31$). There was no significant difference in mean operating time between groups ($p < 0.80$). Mean estimated blood loss was significantly lower for SILC compared to CLC ($p < 0.007$). Mean lymph node extraction was comparable between groups in the subset of patients with malignant disease ($p < 0.68$). Two postoperative complications were encountered in each group. The mean length of hospital stay for SILC and CLC was 3.2 ± 1.0 and 3.8 ± 2.1 days, respectively ($p < 0.25$). There were no readmissions or reoperative interventions in either group.
Conclusion Compared with conventional laparoscopic technique, single-incision laparoscopic surgery results in similar intraoperative and postoperative outcomes. The technique avoids use of multiple trocar sites and may safely be performed in patients with a history of previous abdominal surgery while maintaining a short length of hospital stay and low complication rate.

Keywords Single-incision laparoscopic surgery · Sigmoid resection · Colectomy · Colon cancer · Colorectal surgery · Minimally invasive surgery

Single-incision laparoscopic surgery is an emerging modality for minimally invasive colon resection. The first single-incision laparoscopic colon resection was reported by Bucher et al. [1] in July 2008 and involved a single-incision laparoscopic right hemicolectomy for a benign polyp. A year later, the first series of single-incision colectomies (one left and six right hemicolectomies) was published [2]. Numerous case reports and series describing the safety and feasibility of single-incision colectomy have since been published [3–11]. These series have reported promising initial outcomes, with the potential for improved cosmesis, decreased pain, and diminished risk of incisional hernias. Nevertheless, published series comparing single-

Presented at the SAGES 2011 Annual Meeting, March 30–April 2, 2011, San Antonio, TX.

D. I. Ramos-Valadez · M. Ragupathi · J. Nieto · C. B. Patel · S. Miller · T. B. Pickron · E. M. Haas (✉)
Division of Minimally Invasive Colon and Rectal Surgery, Department of Surgery, University of Texas Medical School at Houston, 7900 Fannin Street, Suite 2700, Houston, TX 77054, USA
e-mail: ehaasmd@houstoncolon.com

Table 1 Comparison between matched and unmatched cases of single-incision laparoscopic sigmoid resection

Parameter	Matched SILC ($n = 20$)	Unmatched SILC ($n = 4$)	p value
Gender (M/F)[a]	11/9	2/2	<0.88
Age (years)[a]	59.0 ± 10.0 (range = 37–76)	60.3 ± 7.3 (range = 50–67)	<0.78
Pathology[a]	17 benign/3 malignant	2 benign/2 malignant	<0.32
Procedure[a]	15 SC without s-flex takedown (75%)	3 SC without s-flex takedown (75%)	<1.0
	5 SC with s-flex takedown (25%)	1 SC with s-flex takedown (25%)	
ASA[b]	2	2	<1.0
BMI (kg/m^2)	25.9 ± 3.9 (range = 19.5–32.8)	27.1 ± 5.7 (range = 22.1–35.3)	<0.71
PSH	10 (50%)	2 (50%)	<1.0

ASA American Society of Anesthesiologist score, *BMI* body mass index, *PSH* past surgical history, *s-flex* splenic flexure, *SC* sigmoid colectomy, *SILC* single-incision laparoscopic colectomy

[a] Matching criteria

[b] Median value

incision laparoscopic colon resection and laparoscopic colectomy remain limited [12–17], with the primary focus on minimally invasive right hemicolectomy. The aim of this study was to evaluate the utility of single-incision laparoscopic colectomy (SILC) and to assess whether the proven safety, short-term benefits, and efficacy of conventional laparoscopic colectomy (CLC) are maintained with the SILC approach. We present a matched-case comparative analysis of outcomes following CLC and SILC for patients undergoing sigmoid resection for benign and malignant disease.

Material and methods

Seventy-seven patients underwent SILC for benign or malignant pathology between July 2009 and September 2010. Single-incision technique was considered for all patients during the study period unless they (1) had an American Society of Anesthesiologist (ASA) score of 4 or 5, (2) required emergency surgery for a pressing medical condition, or (3) presented with middle or lower rectal disease, large bulky malignant disease, or complicated benign disease (fistula, obstruction) [18]. Of the 77 cases, 53 did not involve resection of the sigmoid; these included colostomy creation ($n = 1$) and takedown ($n = 1$), transverse colectomy ($n = 1$), left colectomy ($n = 1$), total colectomy ($n = 8$), and right hemicolectomy ($n = 41$).

Of the remaining 24 SILC procedures, 20 single-incision laparoscopic sigmoid resections were matched to 20 conventional laparoscopic sigmoid colectomies based on four matching criteria: gender, age, pathology (benign or malignant), and type of procedure (sigmoid colectomy with or without takedown of the splenic flexure). Comparable CLC cases were unable to be matched with the remaining four SILC cases. There were no major differences between the 20 SILC cases that were matched and the 4 SILC cases that were unmatched (Table 1). The CLC cases represented both matched cases completed prior to initiating our SILC experience ($n = 17$) and cases performed during (i.e., those excluded from SILC technique) the study interval ($n = 3$).

Demographic data, intraoperative parameters, and postoperative outcomes were collected and entered into an Institutional Review Board-approved database. Demographic data, including age, gender, body mass index (BMI), ASA score, and history of prior abdominal surgery, were tabulated. Intraoperative parameters, including incision length (IL), estimated blood loss (EBL), total operative time (OT), and conversion rate, were analyzed. Postoperative outcomes, including the length of hospital stay (LOS), complication rate, need for reintervention, and readmission rate, were assessed.

Operative technique

Each procedure was performed by one of two board-certified colorectal surgeons (EMH and TBP). The SILC procedures were performed using one of three access devices: SILS™ Port (Covidien, Mansfield, MA, USA), GelPOINT™ (Applied Medical, Rancho Santa Margarita, CA, USA), or GelPort® (Applied Medical). Standard nonarticulated laparoscopic instrumentation and a 5-mm 30° camera with a right-angle light cord adaptor (KARL STORZ, El Segundo, CA, USA) were utilized for all procedures. Our standard laparoscopic approach differed from the SILC approach only in the number of ports used and method of entry to achieve successful resection. In the CLC cases, initial entry was achieved using a 5-mm optical access trocar (Optiview system, Ethicon Endo-Surgery, Cincinnati, OH, USA) under direct visualization. Once pneumoperitoneum was established, two additional 5-mm

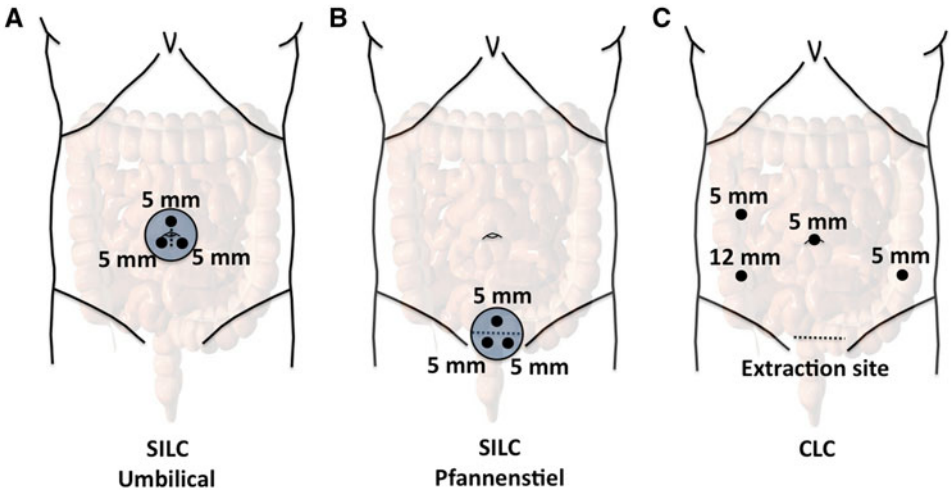

Fig. 1 Port placement for sigmoid resection. **A** Transumbilical SILC approach. **B** Pfannenstiel SILC approach. **C** CLC approach

trocars and one 12-mm trocar were placed in the right lower quadrant or suprapubic region (Fig. 1).

We have previously described our SILC technique for sigmoid resection [19]. Briefly, the patient was placed in a modified lithotomy position following induction of anesthesia. The single-incision access device was placed through a 2.5-cm transumbilical ($n = 17$) or 4-cm Pfannenstiel skin incision ($n = 3$). In the majority of cases, the procedure was performed through a medial-to-lateral approach (at the discretion of the operating surgeon). Following vascular control and mobilization, the specimen was extracted through an Alexis® wound retractor (Applied Medical) placed in the single-incision site. The specimen was resected and a purse-string suture was placed, followed by intracorporeal anastomosis using an ECS 29a circular stapler (Ethicon Endo-Surgery). Both groups were placed on identical postoperative enhanced recovery pathways [13].

Statistical analysis

Data analysis was performed using Intercooled Stata version 9.2 (Stata Corporation, College Station, TX). Categorical parameters, summarized as percentages, were compared with the χ^2 test. For continuous variables, a paired two-tailed Student's *t*-test was performed, with a significance level of $\alpha = 0.05$.

Results

A total of 40 patients who underwent SILC ($n = 20$) and CLC ($n = 20$) were matched based on four criteria (Table 2): gender ($p < 1.0$), age ($p < 0.47$), pathology ($p < 1.0$), and surgical procedure ($p < 1.0$). The mean age was 57.7 ± 11.3 years (range = 35–82 years), the mean BMI was 27.7 ± 4.9 kg/m^2 (range = 19.5–47.5 kg/m^2), and the

Table 2 Demographic information and preoperative parameters

Parameter	All patients	SILC	CLC	*p* value
Gender (M/F)[a]	22/18	11/9	11/9	<1.0
Age (years)[a]	57.7 ± 11.3 (range = 35–82)	59.0 ± 10.0 (range = 37–76)	56.4 ± 12.6 (range = 35–82)	<0.47
Pathology[a]	34 benign/6 malignant	17 benign/3 malignant	17 benign/3 malignant	<1.0
Procedure[a]	40 SC	15 SC without s-flex takedown (75%) 5 SC with s-flex takedown (25%)	15 SC without s-flex takedown (75%) 5 SC with s-flex takedown (25%)	<1.0
ASA[b]	2	2	2	<0.44
BMI (kg/m^2)	27.7 ± 4.9 (range = 19.5–47.5)	25.9 ± 3.9 (range = 19.5–32.8)	29.6 ± 5.4 (range = 21.9–47.5)	<0.021*
PSH	18 (45%)	10 (50%)	8 (40%)	<0.53

ASA American Society of Anesthesiologist score, *BMI* body mass index, *CLC* conventional laparoscopic colectomy, *PSH* past surgical history, *s-flex* splenic flexure, *SC* sigmoid colectomy, *SILC* single-incision laparoscopic colectomy

[a] Matching criteria

[b] Median value

* Significant difference

median ASA was 2 (range = 2–3) for all patients. There was a statistically significant difference in BMI (not used for matching) between the SILC (25.9 ± 3.9 kg/m^2) and CLC (29.6 ± 5.4 kg/m^2) groups ($p < 0.021$). Ten patients (50%) in the SILC group and eight patients (40%) in the CLC group had a history of prior abdominal surgery ($p < 0.53$).

A single incision was initially utilized for all SILC cases, while the CLC procedures required four trocars and an extraction site incision. There were no conversions to open surgery in either group; however, one SILC procedure (5%) required two supplementary trocars for completion (Table 3). In the SILC group, the mean incision length was 3.3 ± 0.8 cm, whereas the mean extraction site incision length was 3.2 ± 0.6 in the CLC group ($p < 0.70$). There was no significant difference between groups in the mean operative time (159.2 ± 29.9 min for SILC and 162.1 ± 40.3 min for CLC, $p < 0.80$), and no intraoperative complications were encountered during any of the procedures. The mean estimated blood loss was significantly lower (58.3 ± 34.3 ml versus 98.9 ± 52.1 ml) for SILC compared to CLC ($p < 0.007$). In the subset of patients with malignant disease ($n = 6$), all surgical margins were negative and the mean lymph node extraction was comparable between groups (20.3 ± 3.8 for SILC and 18.3 ± 6.8 for CLC, $p < 0.68$).

In regard to length of hospital stay, there was no significant difference (3.2 ± 1.0 days versus 3.8 ± 2.1 days) between the SILC group and the CLC group ($p < 0.25$). Two postoperative complications were encountered in each group (10%). In the SILC group, a wound seroma and a hematoma were encountered and managed conservatively in two patients, while in the CLC group, two patients developed ileus requiring nasogastric tube decompression. There were no reoperative interventions or readmissions for any of the patients in either group.

Discussion

Single-incision laparoscopic surgery has emerged as a safe and feasible minimally invasive approach for the treatment of benign and malignant diseases of the colon. The technique has been employed successfully for a number of colorectal procedures, including right hemicolectomy [2, 4, 6, 8, 9, 20–25], total colectomy [26–28], proctocolectomy with ileal pouch anal anastomosis [28, 29], and left colectomy [2, 25, 30]. Several case reports and series have been published involving use of the SILC technique for sigmoid resection [3, 7, 31–38], the largest of which included 10 consecutive patients who underwent resection for recurrent diverticulitis [38]. These reports concluded that SILC was safe and feasible without increased operative time, risk of complication, or prolonged hospitalization when performed by an experienced laparoscopic surgeon. Currently, there are six studies comparing SILC and laparoscopic surgery in the published literature [12–17]; however, only one of these included a subset of patients who underwent conventional laparoscopic sigmoid resection [15]. We present a case-matched comparative analysis comprised exclusively of sigmoid resections to compare intraoperative and postoperative outcomes and to evaluate the efficacy of the SILC technique.

All cases were completed without conversion to open surgery. One SILC case required salvage with multiport laparoscopic technique to facilitate primary oversewing of the anastomosis following a positive air-leak insufflation test. Operative time and perioperative complication rates were comparable between the two groups. Although longer operative times have been reported for single-incision laparoscopic procedures [15], this was not true in our series as the operative times were nearly identical between the two modalities. This finding most likely reflects the learning curve of SILC being overcome during our initial experience with right hemicolectomy [6]. There was significantly diminished EBL in the SILC group; however,

Table 3 Intraoperative and postoperative outcomes following SILC and CLC

Parameter	SILC	CLC	*p* value
Conversion to open surgery (%)	0%[a]	0%	<1.0
EBL (ml)	58.3 ± 34.3	98.9 ± 52.1	<0.007*
Operative time (min)	159.2 ± 29.9	162.1 ± 40.3	<0.80
Lymph node extraction (malignant cases only, $n = 3$)	20.3 ± 3.8	18.3 ± 6.8	<0.68
Length of stay (days)	3.2 ± 1.0	3.8 ± 2.1	<0.25
Complications (%)	10%	10%	<1.0

CLC conventional laparoscopic colectomy, *EBL* estimated blood loss, *SILC* single-incision laparoscopic colectomy

[a] One case converted to multiport laparoscopic surgery

* Significant difference

this was not clinically significant as blood transfusion was not necessary in either group of patients. All patients followed identical postoperative recovery pathways [13] and the length of hospital stay was similar in the SILC (3.2 days) and CLC groups (3.8 days).

Both SILC and CLC procedures were completed using standard laparoscopic instrumentation. Articulating instruments were not considered for SILC as they were not readily available and may have contributed to increased cost and technical complexity of the procedure. We recommend utilizing instrumentation of variable lengths, such as a bariatric-length bowel grasper or an extra long camera, to minimize external clashing. This may prove especially beneficial when mobilization of the splenic flexure is required, which we completed without significant difficulty during five SILC procedures. Additionally, a right-angle light-cord adaptor for the camera greatly reduces external conflict during laparoscopic maneuvers.

Coaxial alignment of instrumentation through a single access point can result in frequent internal collisions, thus restricting range of motion and visualization. The resulting loss of triangulation must be overcome by technical maneuvers acquired during the learning curve phase of this technique. We recommend a medial-to-lateral approach, with early identification, isolation, and ligation of the inferior mesenteric artery (IMA) followed by retroperitoneal dissection. With the lateral attachments assisting in the elevation of the colon and mesentery, this approach facilitates triangulation through use of a single grasper (i.e., single-grasper triangulation). A "hand-over-fist" maneuver is utilized to reduce clashing and optimize retraction and dissection of the tissue planes during SILC (Fig. 2A). As one instrument (i.e., "fist") elevates or tents the tissues, the opposite instrument (i.e., "hand") dissects along the avascular plane (Fig. 2B). When further dissection cannot be accomplished, the roles of the instruments are reversed to advance the procedure.

We found a significant difference in the BMI between the laparoscopic group (29.6 ± 5.4 kg/m^2) and the single-incision group (25.9 ± 3.9 kg/m^2). The difference was attributed to two patients in the laparoscopic group, one with a BMI of 35.1 kg/m^2 and another with a BMI of 47.5 kg/m^2. Although BMI was not one of the four matching criteria, this significant difference is a limitation of this series and should be considered when evaluating the results. It should be noted, however, that both patient groups had a mean BMI within the range of 25–30 kg/m^2, which we previously found to be associated with significantly prolonged operative time in a series of single-incision laparoscopic right hemicolectomies [6]. Another potential limitation of this study is that it involved two surgeons. Each surgeon (EMH and TBP) has extensive experience with conventional laparoscopic technique (over 500 cases each) and both began utilizing the single-incision approach between July and August 2009. In this series, the surgeons contributed nearly equal numbers of patients to each arm of the study, thereby minimizing the potential for surgeon population bias.

When compared with conventional laparoscopic technique, single-incision laparoscopic surgery maintains the same short-term benefits of minimally invasive colon resection, including short hospital length of stay and low complication rate. Cosmesis has been described as one of the primary benefits of single-incision laparoscopic surgery; however, we believe the most important benefit is the avoidance of multiple trocar sites. Although complications have been reported at an incidence of only 0.2–0.3%, trocar site insertion has been associated with devastating vascular, bowel, and other intra-abdominal injuries in certain cases [39]. Furthermore, the trocar site hernia rate has been reported as high as 5% in the literature [40] and typically requires reoperative intervention. The SILC technique avoids the complications associated with multiple trocar sites, can be safely offered to those patients with prior

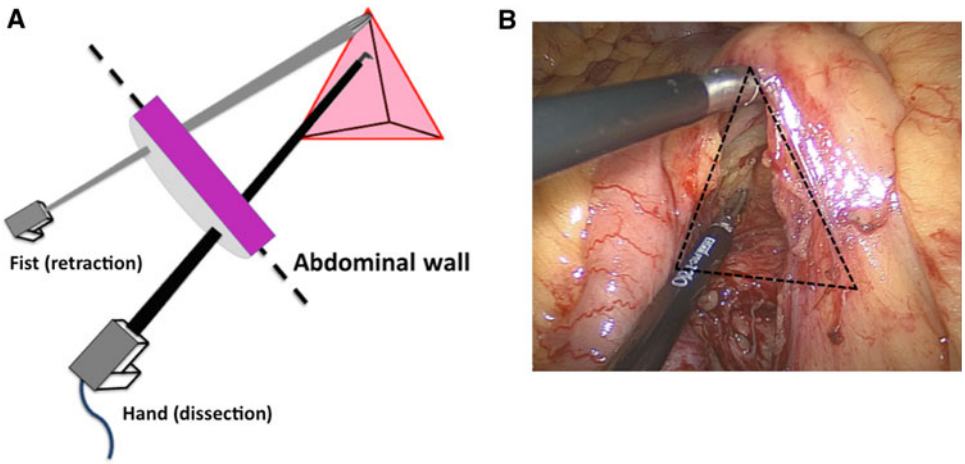

Fig. 2 Single-grasper triangulation technique. **A** Depiction of "hand-over-fist" maneuver. **B** Intraoperative view of single-grasper retraction and dissection

abdominal surgery, and does not require longer operative time.

Disclosure Dr. Pickron is a preceptor for Applied Medical (Rancho Santa Margarita, CA, USA) and Ethicon Endo-Surgery (Cincinnati, OH, USA). Dr. Haas is a preceptor for Applied Medical (Rancho Santa Margarita, CA, USA). Drs. Ramos-Valadez, Ragupathi, Nieto, Patel, and Miller have no conflicts of interest or financial ties to disclose.

References

1. Bucher P, Pugin F, Morel P (2008) Single port access laparoscopic right hemicolectomy. Int J Colorectal Dis 23:1013–1016
2. Rieger NA, Lam FF (2009) Single-incision laparoscopically assisted colectomy using standard laparoscopic instrumentation. Surg Endosc 24:888–890
3. Brunner W, Schirnhofer J, Waldstein-Wartenberg N, Frass R, Weiss H (2010) Single incision laparoscopic sigmoid colon resection without visible scar: a novel technique. Colorectal Dis 12:66–70
4. Remzi FH, Kirat HT, Kaouk JH, Geisler DP (2008) Single-port laparoscopy in colorectal surgery. Colorectal Dis 10:823–826
5. Chambers W, Bicsak M, Lamparelli M, Dixon A (2011) Single-incision laparoscopic surgery (SILS) in complex colorectal surgery: a technique offering potential and not just cosmesis. Colorectal Dis 13:393–398
6. Ramos-Valadez DI, Patel CB, Ragupathi M, Bartley Pickron T, Haas EM (2010) Single-incision laparoscopic right hemicolectomy: safety and feasibility in a series of consecutive cases. Surg Endosc 24:2613–2616
7. Bucher P, Pugin F, Morel P (2009) Single-port access laparoscopic radical left colectomy in humans. Dis Colon Rectum 52:1797–1801
8. Boni L, Dionigi G, Cassinotti E, Di Giuseppe M, Diurni M, Rausei S, Cantore F, Dionigi R (2010) Single incision laparoscopic right colectomy. Surg Endosc 24:3233–3236
9. Merchant AM, Lin E (2009) Single-incision laparoscopic right hemicolectomy for a colon mass. Dis Colon Rectum 52: 1021–1024
10. Patel CB, Ramos-Valadez DI, Ragupathi M, Haas EM (2010) Single incision laparoscopic-assisted right hemicolectomy: technique and application (with video). Surg Laparosc Endosc Percutan Tech 20:e146–e149
11. Uematsu D, Akiyama G, Magishi A, Nakamura J, Hotta K (2010) Single-access laparoscopic left and right hemicolectomy combined with extracorporeal magnetic retraction. Dis Colon Rectum 53:944–948
12. Adair J, Gromski MA, Lim RB, Nagle D (2010) Single-incision laparoscopic right colectomy: experience with 17 consecutive cases and comparison with multiport laparoscopic right colectomy. Dis Colon Rectum 53:1549–1554
13. Gandhi DP, Ragupathi M, Patel CB, Ramos-Valadez DI, Pickron TB, Haas EM (2010) Single-incision versus hand-assisted laparoscopic colectomy: a case-matched series. J Gastrointest Surg 14:1875–1880
14. Waters JA, Guzman MJ, Fajardo AD, Selzer DJ, Wiebke EA, Robb BW, George VV (2010) Single-port laparoscopic right hemicolectomy: a safe alternative to conventional laparoscopy. Dis Colon Rectum 53:1467–1472
15. Champagne BJ, Lee EC, Leblanc F, Stein SL, Delaney CP (2011) Single-incision vs straight laparoscopic segmental colectomy: a case-controlled study. Dis Colon Rectum 54:183–186
16. Chen WT, Chang SC, Chiang HC, Lo WY, Jeng LB, Wu C, Ke TW (2011) Single-incision laparoscopic versus conventional laparoscopic right hemicolectomy: a comparison of short-term surgical results. Surg Endosc 25(6):1887–1892
17. Papaconstantinou HT, Sharp N, Thomas JS (2011) Single-incision laparoscopic right colectomy: a case-matched comparison with standard laparoscopic and hand-assisted laparoscopic techniques. J Am Coll Surg 213(1):72–80
18. Ramos-Valadez DI, Patel CB, Ragupathi M, Bokhari MB, Pickron TB, Haas EM (2011) Single-incision laparoscopic colectomy: outcomes of an emerging minimally invasive technique. Int J Colorectal Dis 26(6):761–767
19. Ragupathi M, Ramos-Valadez DI, Yaakovian MD, Haas EM (2011) Single-incision laparoscopic colectomy: a novel approach through a Pfannenstiel incision. Tech Coloproctol 15:61–65
20. Keshava A, Young CJ, Mackenzie S (2010) Single-incision laparoscopic right hemicolectomy. Br J Surg 97:1881–1883
21. Pietrasanta D, Romano N, Prosperi V, Lorenzetti L, Basili G, Goletti O (2010) Single-incision laparoscopic right colectomy for cancer: a single-centre preliminary experience. Updates Surg 62:111–115
22. Wong MT, Ng KH, Ho KS, Eu KW (2010) Single-incision laparoscopic surgery for right hemicolectomy: our initial experience with 10 cases. Tech Coloproctol 14:225–228
23. Keshava A, Mackenzie S, Al-Kubati W (2010) Single-port laparoscopic right colonic resection. ANZ J Surg 80:30–32
24. Choi SI, Lee KY, Park SJ, Lee SH (2010) Single port laparoscopic right hemicolectomy with D3 dissection for advanced colon cancer. World J Gastroenterol 16:275–278
25. Law WL, Fan JK, Poon JT (2010) Single-incision laparoscopic colectomy: early experience. Dis Colon Rectum 53:284–288
26. Bardakcioglu O, Ahmed S (2010) Single incision laparoscopic total abdominal colectomy with ileorectal anastomosis for synchronous colon cancer. Tech Coloproctol 14:257–261
27. Cahill RA, Lindsey I, Jones O, Guy R, Mortensen N, Cunningham C (2010) Single-port laparoscopic total colectomy for medically uncontrolled colitis. Dis Colon Rectum 53:1143–1147
28. Leblanc F, Makhija R, Champagne BJ, Delaney CP (2011) Single incision laparoscopic total colectomy and proctocolectomy for benign disease—initial experience. Colorectal Dis. doi: 10.1111/j.1463-1318.2010.02448.x
29. Geisler DP, Condon ET, Remzi FH (2010) Single incision laparoscopic total proctocolectomy with ileopouch anal anastomosis. Colorectal Dis 12:941–943
30. Law WL, Fan JK, Poon JT (2010) Single incision laparoscopic left colectomy for carcinoma of distal transverse colon. Colorectal Dis 12:698–701
31. Bucher P, Pugin F, Morel P (2010) Transumbilical single incision laparoscopic sigmoidectomy for benign disease. Colorectal Dis 12:61–65
32. Ishida H, Okada N, Ishibashi K, Ohsawa T, Kumamoto K, Haga N (2011) Single-incision laparoscopic-assisted surgery for colon cancer via a periumbilical approach using a surgical glove: Initial experience with 9 cases. Int J Surg 9:150–154
33. Leroy J, Cahill RA, Asakuma M, Dallemagne B, Marescaux J (2009) Single-access laparoscopic sigmoidectomy as definitive surgical management of prior diverticulitis in a human patient. Arch Surg 144:173–179
34. Podolsky ER, Curcillo PG 2nd (2010) Single port access (SPA) surgery—a 24-month experience. J Gastrointest Surg 14:759–767
35. Remzi FH, Kirat HT, Geisler DP (2010) Laparoscopic single-port colectomy for sigmoid cancer. Tech Coloproctol 14:253–255
36. Takemasa I, Sekimoto M, Ikeda M, Mizushima T, Yamamoto H, Doki Y, Mori M (2010) Video. Transumbilical single-incision laparoscopic surgery for sigmoid colon cancer. Surg Endosc 24:2321

37. Uematsu D, Akiyama G, Matsuura M, Hotta K (2010) Single-access laparoscopic colectomy with a novel multiport device in sigmoid colectomy for colon cancer. Dis Colon Rectum 53: 496–501
38. Vestweber B, Alfes A, Paul C, Haaf F, Vestweber KH (2010) Single-incision laparoscopic surgery: a promising approach to sigmoidectomy for diverticular disease. Surg Endosc 24: 3225–3228
39. Hashizume M, Sugimachi K (1997) Needle and trocar injury during laparoscopic surgery in Japan. Surg Endosc 11:1198–1201
40. Helgstrand F, Rosenberg J, Bisgaard T (2011) Trocar site hernia after laparoscopic surgery: a qualitative systematic review. Hernia 15:113–121