ORIGINAL CONTRIBUTION

Single-Port Laparoscopic Right Hemicolectomy: A Safe Alternative to Conventional Laparoscopy

Joshua A. Waters, M.D. • Michael J. Guzman, M.D. • Alyssa D. Fajardo, M.D.
Don J. Selzer, M.D. • Eric A. Wiebke, M.D. • Bruce W. Robb, M.D.
Virgilio V. George, M.D.

Indiana University Department of Surgery, Indianapolis, Indiana

PURPOSE: Single-port laparoscopic surgery has evolved from an effort to minimize tissue trauma, limit morbidity, and maximize cosmesis. Limited data exist comparing single-port with conventional laparoscopy for right colectomy. Our aim is to compare single-port with laparoscopic colectomy with regard to safety and feasibility. We assert that this approach can be adopted in a safe and efficacious manner while using standard laparoscopic instrumentation.

METHODS: This is a retrospective analysis of prospectively gathered data regarding 16 single-port and 27 conventional laparoscopic right hemicolectomies performed by a single surgeon between January 2008 and February 2009. Demographics, operative outcomes, and morbidity were included and analyzed using either Student *t* test or Fisher exact probability test.

RESULTS: Single-port and conventional laparoscopic groups were similar with regard to age, gender, body mass index, prior abdominal surgery, and co-morbidity. Seventy-five percent and 70% of the operations were performed for malignancy in the single-port and the conventional laparoscopy group, respectively ($P = .69$). Operative duration was 106 minutes in the single-port group vs 100 minutes in the conventional group ($P = .64$). Blood loss was 54 mL and 90 mL, respectively ($P = .07$). No conversions or additions of ports occurred. Hospital stay was 5.3 days in the single-port group vs 6 days in the conventional group ($P = .53$). Margins were negative in both groups. Mean lymph node number was 18 and 16 nodes ($P = .92$). There was one death in the conventional group ($P = .44$). Morbidity including wound infection was 18.8% and 14.9%, respectively ($P = .73$).

CONCLUSIONS: These findings support single-port right colectomy as a safe and efficacious approach to right colon resections in patients eligible for laparoscopy with minimal additional equipment or learning curve for experienced laparoscopic colorectal surgeons. The single port was undertaken without an increase in morbidity or mortality. There was no increase in operative time with use of the single-port approach. Finally, adequate lymph node harvest and margin clearance was maintained.

KEY WORDS: Laparoscopy; Colon cancer; Outcomes research; Colon and rectal surgery.

Minimizing the operative footprint, in terms of tissue trauma, cosmesis, and morbidity, has become an increasingly important goal in colorectal surgery.[1] This has taken a number of forms, most notably single-port laparoscopic surgery (SPLS) (also known as SILS, SPA, or LESS) and natural orifice transluminal endosocopic surgery.[2] Single-port surgery is a relatively recent addition to the minimally invasive colorectal armamentarium.[3–6] Since the initial descriptions of single-port surgery in the field of gynecology, this approach has grown in use in a number of other surgical disciplines.[7–13] The first single-port procedure in general surgery can be traced back to Navarra and colleagues[14] who described a transumbilical cholecystectomy in 1997. This novel approach was used and described for resection of the right colon by both Bucher et al[15] and Remzi et al[16] in 2008.

Single-port surgical access presents a number of potential benefits. The most obvious benefit relates to limiting the cosmetic disturbance related to a reduction in

Financial Disclosures: None reported.

Presented at meeting of The American Society of Colon and Rectal Surgeons, Minneapolis, MN, May 15 to 19, 2010.

Correspondence: Virgilio V. George, M.D., 545 Barnhill Dr, EH 202, Indianapolis, IN 46202. E-mail: vigeorge@iupui.edu.

Dis Colon Rectum 2010; 53: 1467–1472
DOI: 10.1007/DCR.0b013e3181f23ca0

number of abdominal incisions. In addition, authors have suggested reductions in postoperative pain and narcotic use compared with conventional laparoscopy.[17] Similarly, a number of possible drawbacks to implementing this technique exist, including a difficult learning curve, compromises in exposure or visualization, increased operative time, compromised oncologic outcome, patient safety/surgical complications, inadequate technology, and increases in equipment and operative costs.

Many questions remain regarding the utility and importance of single-port operative approaches, in general, and, in particular, as they relate to colorectal surgery. Although a number of small series and case reports exist in the literature, no comparative study of single-port and conventional laparoscopic colectomy has been described to date.[3,15,16,18] Although improvements in cosmesis and reductions in postoperative pain are laudable goals, these clearly must not be pursued at the expense of safety or efficiency. The primary aim of this study is to compare a laparoscopically trained colorectal surgeon's experience and outcomes with a single-port and a conventional multiple-port laparoscopic approach to right colectomy. We assert that single-port access for right colectomy can be performed safely, efficiently, and with similar efficacy, using standard laparoscopic optics and instrumentation, compared with the conventional multiple-port laparoscopic approach.

MATERIALS AND METHODS

Patient Selection

All patients included and data collected in this study were done so in strict compliance and clearance of the Institutional Review Board at Indiana University School of Medicine (Indianapolis , IN). The study period of interest was between January 2008 and February 2009. During this period, all laparoscopic right hemicolectomies performed using either single-port or conventional laparoscopic techniques were gathered prospectively. There were no crossovers between these 2 groups. Patients were included regardless of indication in this analysis. Patients undergoing urgent or emergent colectomy, or those with T4 tumors, were not considered for the single-port approach. In this series no patient declined the single-port approach. In each case, the operative approach was based on surgeon and patient preference. Each patient undergoing the single-port access approach was informed of the alternative conventional approach.

Parameters Assessed

Data for each of these patients were entered prospectively into an electronic database using Microsoft excel 2007 (Redmond, WA). Patient factors and demographics were assessed including: age, gender, body mass index (BMI), and prior abdominal surgery. The ASA classification was used as a surrogate for operative risk. Operative indication was also assessed. The operations were divided based on whether they were performed for malignancy or benign disease. Intraoperative factors were compared, including estimated blood loss, operative time (measured from skin incision to closure), conversion rate, and specimen length. Oncologic adequacy was assessed in operations performed for malignancy, utilizing the overall number of lymph nodes and the proportion of positive margins. The surgical resection margin was counted as positive whether in the radial, proximal, or distal margin. Finally, postoperative characteristics were compiled that included duration of stay, postoperative morbidity, readmission rate, and 30 days overall mortality. Morbidity was defined as any postoperative complication including wound infection.

Operative Technique

The primary technical difference between SPLS and conventional laparoscopic approaches was in regard to access. No flexible-tipped cameras or specialized reticulating instruments were used in either case. A 5-mm, 30-degree laparoscope was used for both conventional and SPLS cases. The conventional laparoscopic approach uses 3 ports in total. This includes 2 × 5 mm working ports, and a 5-mm port placed through the umbilicus that accommodates the laparoscopic camera. This port was enlarged to 2.5 or 4.5 cm to allow for the externalization of the colon to allow for anastomosis. In the case of SPLS, a single vertical incision, approximately 2 cm in length, is created through the umbilicus to accommodate the single-port access device. This was enlarged to 2.5 or 4.5 cm to accommodate the bowel. The final umbilical extraction port size was dictated by colon and lesion size, not by the approach used. The SILS port from Covidien Inc. (Mansfield, MA) was used for SPLS cases. This port includes an insufflation attachment and 3 access ports. These ports can be stretched to accommodate up to 2 × 5 mm and a 12-mm port. A 5-mm laparoscope and 2 × 5 mm instruments were used during SPLS right colectomy.

In conventional laparoscopic cases, access is gained in the abdomen using a 5-mm translucent trocar system via the umbilicus. In the single-port cases, entry via the umbilicus is gained by use of an open technique.

In both the single-port and conventional laparoscopic approaches the operative procedure proceeds in much the same way. The dissection occurs in a medial to lateral fashion. The ileocolic pedicle is elevated to allow dissection beneath the ileocolic vessels with identification of the origin of the right colic artery and then the duodenum. The ileocolic vascular pedicle undergoes high ligation with use of an energy device. The right colon and proximal transverse colon are then elevated off the retroperitoneum. The portion of the omentum attached to the specimen is then divided proximally. The right branch of the middle colic (if

TABLE 1. Patient demographics and indications

	Single port (n = 16)	*Conventional (n = 27)*	*P*
Age (y)	65 (39–82)	67 (40–91)	.69
Gender, n (% male)	8 (50)	15 (55)	.75
ASA score	2.5	2.8	.06
Body mass index	29 (20–41)	29 (18–45)	.93
Prior abdominal surgery, n (%)	7 (44)	10 (37)	.73
Indication			
Malignant	12 (75)	19 (70)	.69
Benign	4 (25)	7 (30)	

present) is divided. The attachments comprising the hepatic flexure are taken down, and the lateral peritoneal reflection is divided. After placement of a wound protector, the specimen is then exteriorized via the umbilical incision. An ileocolic side-to-side, functional end-to-end stapled anastomosis is created. The bowel is returned to the abdomen, and then reexamined in situ. The mesenteric defect is not closed in either laparoscopic or SPLS approaches. The fascial incision in either case is closed using figure-of-eight No. 1 PDS suture. Both approaches maintained oncologic principles, with high vascular ligation and minimal tumor manipulation.

Statistical Analysis

Statistical analysis was performed using either Microsoft Excel 2007 or Graph Pad Prism (La Jolla, CA) software. Mean values are reported where the sample normally exhibits a normal distribution. In samples with nonnormal distributions, median values and ranges are reported. Sample means were tested for statistical significance using a Student *t* test, with an accepted *P* value of less than .05 defined as significant. Categorical variables and proportions (ie, morbidity, operative indication, etc) were evaluated using the Fisher exact probability test.

RESULTS

In the 1-year study period 43 minimally invasive right hemicolectomies were performed by a single surgeon (V.G.). The mean age of all patients was 66 (range, 39–91) years. Twenty-three (53%) of these patients were male. The mean BMI was 29 (range, 18–45). Seventeen (40%) of these patients had undergone at least one prior abdominal operation. The mean ASA score for all patients was 2.7 (range, 1–3). The majority (72%) underwent resection for malignancy, whereas only 11 patients underwent resection for benign disease.

Of these 43 patients, 16 (37%) were operated on with the SPLS approach, and 27 (63%) were operated on using the conventional laparoscopic approach. The mean ages and preoperative risk (based on ASA score) were similar between the 2 groups. Approximately half of the patients in each group were male. The mean and BMI measurements were the same at the time of operation in each group at 29, although, the largest patient (BMI 45) was assigned to the conventional group. Forty-four percent and 37% of patients had prior abdominal surgery in the SPLS and conventional approaches, respectively ($P = .73$). Operative indications were similar between the 2 groups. In the SPLS group, 10 operations were performed for adenocarcinoma of the colon. Of the operations for adenocarcinoma, 5 were performed for T3 lesions, 4 were performed for endoscopically unresectable polyps, one was performed for adenocarcinoma of the appendix, and one was performed for carcinoid. Similarly, in the conventional group, 18 operations were performed for adenocarcinoma of the colon; of the adenocarcinomas, 5 were in the T3 tumor stage, 7 were endoscopically unresectable polyps, and one was an appendiceal carcinoid (Table 1).

FIGURE 1. Postoperative photo demonstrating incisions following a single-port laparoscopic right hemicolectomy.

The conventional laparoscopic approaches each had 3 incisions compared with one incision in the SPLS group (Fig. 1). The size of the largest (umbilical) incision in either group was the same (2.5–4.5 cm). No additional ports were added to any of the SPLS cases. Comparisons of intraoperative outcomes are seen in Table 2. There were no conversions to the open technique in either group, and there was no crossover between groups. The mean operative time from skin incision to wound closure was similar

TABLE 2. Intraoperative outcomes

	Single port	*Conventional*	*P*
Margins (% positive)	0	0	n/a
Lymph nodes (n)	18 (13–22)	16 (10–21)	.1
Specimen length (cm)	18 (14–35)	18 (7–32)	.92
Blood loss (mL)	54 (25–120)	90 (25–300)	.07
Operative time (min)	106 (71–223)	100 (65–215)	.64
Conversion rate (%)	0	0	n/a

n/a = not applicable.

TABLE 3. Postoperative outcomes

	Single port	*Conventional*	*P*
30-day mortality, n (%)	0	1 (4)	.44
Overall morbidity, n (%)	3 (19)	4 (15)	.99
Wound infection	1	1	
Intra-abdominal abscess	1	1	
Leak/reoperation	0	1	
Renal failure	1	1	
Myocardial infarction	0	1	
Mean hospital stay (d)	5 (2–24)	6 (2–28)	.53
Median hospital stay (d)	4	5	
Readmission, n (%)	1 (6)	1 (4)	.99

between the SPLS group (106 minutes) and the conventional group (100 minutes) ($P = .64$). Mean intraoperative blood loss was 54 mL in the SPLS group and 90 mL in the conventional group, although this difference was not significant ($P = .07$). The extent of resection was similar in either group, with the mean length of specimen equivalent at 18 cm.

Most colon resections in this series were performed for malignancy. There was no difference in the lymphadenectomy performed, with 18 and 16 lymph nodes obtained in the SPLS and conventional approaches, respectively. No cases had less than 12 lymph nodes in the SPLS group, and only one case (an adenoma) had less than 12 nodes in the conventional group. There were no positive gross or microscopic surgical margins in this series.

There was a single mortality in this series (2%), which occurred in the conventional laparoscopic group. This patient had a postoperative myocardial infarction that resulted in death. There was no in-hospital or 30-day mortality in the SPLS group. Overall postoperative morbidity was 16%. Morbidity was similar between the groups and is detailed in Table 3. One patient in the conventional laparoscopic group required reoperation for an anastomotic leak. One patient in each group developed an intra-abdominal abscess. Each of these occurred in the area of the anastomosis after discharge and required subsequent readmission. These abscesses were managed with percutaneous drainage.

There was no significant difference in median duration of postoperative hospital stay between SPLS (4 d) and conventional groups (5 d) ($P = .53$). One patient in each group was readmitted postoperatively.

DISCUSSION

We examined the initial experience of single-port access compared with concurrent conventional laparoscopic approach for right hemicolectomy. To our knowledge, this is the first published comparison of these 2 approaches for minimally invasive colectomy. These data support that a single-port approach can be used by experienced laparoscopic colorectal surgeons safely, efficiently, and effectively. This comes with the added benefit of improved cosmetic results with minimal increases in cost or time.

One of the important questions regarding the use of single-port surgery involves intraoperative efficiency. An important concern in adopting any new technique or technology is the associated learning curve. These data address that question directly, in that, these 16 SPLS right hemicolectomies were the first performed by this surgeon, and include the initial learning curve. It is important to note that before this time period, this surgeon had performed more than 100 laparoscopic colon resections independently. Commonly used surrogates for learning a new technique include operative time, intraoperative blood loss, and conversions.[19,20] When looking specifically at operative time, no difference was noted in either approach. Although clearly some learning curve exists with this technique, no obvious differences were observed with regard to operative times in the earliest and latest cases. An important qualifier with regard to operative time is that the involvement of surgical residents was more prevalent in the conventional laparoscopic cases compared with the single-port approach. This factor could certainly bias the operative time results significantly. In addition, similar amounts of blood loss were seen in either group. Although a conversion to an open technique or the use of additional ports would clearly not represent a complication, they would demonstrate some difficulty in progressing with a single-port technique. In this series, no conversions occurred, and no additional ports were required in either group. The operative efficiency maintained when transitioning from conventional laparoscopic to single port can be explained, in part, because of 2 main factors. The first is an existing level of experience and comfort with laparoscopic principles, as well as the conventional laparoscopic approach to this operation. The second is the use of standard laparoscopic instrumentation and optics. Prior experience with this equipment allows operating room staff and the surgeon to minimize additional familiarization needed to conduct the operation.

The next set of outcomes addressed in this series involved efficacy of this approach. It is clear that any benefit gained through the use of a new approach must not jeopardize oncologic principles or patient outcomes. A similar number of operations were performed for malignant indication in each of the operative groups. No patient with a T4 lesion was offered a single-port approach. In addition, no laparoscopic operations in this series were performed for T4 tumor stage. T3 lesions were offered the single-port approach. Tumor size did not affect the ability to complete the operation via a single port, although externalization of larger tumors required enlargement of the umbilical port in both conventional and SPLS cases. In these patients, the short-term metrics with regard to the oncologic adequacy

rely primarily on margin status and degree of lymphadenectomy.[21] In both cases, the single-port approach did not compromise those measures. In all cases of malignancy in either group, the number of lymph nodes exceeded the acceptable level of 12 nodes. In addition, no margins were found to be grossly or microscopically positive on final pathologic examination. Regardless of approach, the oncologic principles of high vascular ligation and minimal tumor manipulation were maintained.

Any novel approach must be implemented safely and without increasing the relative risk of morbidity or mortality. This is perhaps the most important element examined in this comparison. These data demonstrate no difference in postoperative morbidity or mortality associated with SPLS right hemicolectomy. The number and type of postoperative complications were similar in each group. Identical rates of deep and superficial surgical site infections were noted. The reported morbidity in large series of laparoscopic colon resections is 20% to 22%,[22,23] although these data represent a combination of different colon resections, and the complication rate is lower for elective right colectomy.[24] The present series demonstrates complication rates in both groups that are consistent with previously published data with respect to overall and surgical morbidity.[25,26]

As experience with laparoscopic colectomy grows, one of the reproducible advantages is a decreased length of hospital stay compared with open surgery. These data demonstrate that this outcome is maintained but not improved in SPLS cases. Median hospital stays of 4 and 5 days in SPLS and conventional laparoscopic groups, respectively, are in line with published series of laparoscopic colon resection.[22] In addition, readmission rates were similar between the 2 groups, occurring in only 2 (5%) patients overall.

When considering the implementation of any new technology, a significant barrier is often the cost of the procedure. Several authors have examined the cost of laparoscopic right hemicolectomy compared with the open approach. In general, the initial operative costs associated with the laparoscopic technique are mitigated by reductions in morbidity and duration of hospital stay in the minimally invasive approach.[27] One particular concern in single-port access is that it will require purchase of proprietary instrumentation and increase operative costs. In this series, the access port allows the use of existing laparoscopic instrumentation, and no new instruments or optics are necessary. The port itself was purchased at a cost of $550 to $650, compared with the ports used in the standard laparoscopic cases that cost an average of $80 each. The marginal increase in direct operative cost was $310 to $410 per case. With similar operative times, and overall duration of stay, it can be inferred that the total increase in cost is only that of the port device itself.

All of these data must be interpreted in the context of several important limitations. The first of these is the retrospective nature of this series. Although the patients were entered into the database in a prospective fashion, some of the outcome data was gathered through retrospective review of the medical record, and is thereby subject to bias. In addition, these patients were not randomly selected with regard to the operative approach. Surgeon and patient discretion clearly introduces potential bias with regard to the similarity of these 2 groups. In an attempt to assess any differences, we compared patient and pathologic factors that would influence the operation. In the case of age, gender, comorbidity, size, and prior abdominal operation (as a surrogate for enteroparietal adhesions), the 2 groups were largely similar, although the ASA score in the conventional group approached the level of statistical significance. The relatively small size of either group also presents some challenges. This can increase the risk of a type II error, and make conclusions regarding similarities between the 2 approaches quite tenuous. The spectrum of disease treated in each group was similar in each group with most operations being performed for malignancy. Although pathologic measures of the oncologic adequacy of these resections could be analyzed in this series, it was not designed nor powered to address the question of survival or term oncologic outcomes.

CONCLUSION

Our experience with SPLS right colectomy supports its use as a safe and efficacious approach to right colon resections, in patients suitable for a laparoscopic approach, with minimal additional equipment, cost, or learning curve.

REFERENCES

1. Moloo H, Sabri E, Wassif E, et al. Laparoscopic resection for colon cancer: would all patients benefit? *Dis Colon Rectum.* 2008; 51:173–180.
2. Zhu, JF. Which term is better: SILS, SPA, LESS, E-NOTES, or TUES? *Surg Endosc.* 2009;23:1164–1165.
3. Chambers WM, Bicsak M, Lamparelli M, Dixon AR. Single-incision laparoscopic surgery (SILS) in complex colorectal surgery: a technique offering potential and not just cosmesis [published online ahead of print December 14, 2009]. *Colorectal Dis.* doi:10.1111/j.1463-1318.2009.02158.x.
4. Geisler DP, Condon, ET, Remzi FH. Single incision laparoscopic total proctocolectomy with ileopouch anal anastomosis [published online ahead of print November 6, 2009]. *Colorectal Dis.* 2010;12:941–943.
5. Leroy J, Cahill RA, Asakuma M, Dallemagne B, Marescaux J. Single-access laparoscopic sigmoidectomy as definitive surgical management of prior diverticulitis in a human patient. *Arch Surg.* 2009;144:173–179.
6. Bucher P, Pugin F, Morel P. Transumbilical single incision laparoscopic sigmoidectomy for benign disease. *Colorectal Dis.* 2010; 12:61–65.
7. Huang CK, Tsai JC, Lo CH, et al. Preliminary surgical results of

single-incision transumbilical laparoscopic bariatric surgery [published online ahead of print January 30, 2010]. *Obes Surg.* doi:10.1007/s11695-009-0071-9.
8. Curcillo PG II, Podolsky ER, Wu AS, et al. Single-port-access (SPA^{tm}) cholecystectomy: a multi-institutional report of the first 297 cases. *Surg Endosc.* 2010;24:1854–1860.
9. Podosky ER, Curcillo PG II. Single port access (SPA) surgery—a 24-month experience. *J Gastronintest Surg.* 2010;14:759–767.
10. Erbella J, Brunch GM. Single-incision laparoscopic cholecystectomy: the first 100 outpatients. *Surg Endosc.* 2010;24:1958–1961.
11. Chow A, Purkayastha S, Nehme J, Darzi LA, Paraskeva P. Single incision laparoscopic surgery for appendicectomy: a retrospective comparative analysis [published online ahead of print March 25, 2010]. *Surg Endosc.* doi:10.1007/s00464-010-1004-3.
12. Targarona EM, Pallares JL, Balague C, et al. Single incision approach for splenic diseases: a preliminary report on a series of 8 cases [published online ahead of print February 23, 2010]. *Surg Endosc.* doi:10.1007/s00464-010-0940-2.
13. Edwards C, Bradshaw, Ahearne P, et al. Single-incision laparoscopic cholecystectomy is feasible: initial experience with 80 cases [published online ahead of print March 3, 2010]. *Surg Endosc.* doi:10.1007/s00464-010-0943-z.
14. Navarra G, Pozza E, Occhionorelli S, Carcoforo P, Donini I. One-wound laparoscopic cholecystectomy. *Br J Surg.* 1997;84:695.
15. Bucher P, Pugin F, Morel P. Single port access laparoscopic right hemicolectomy. *Int J Colorectal Dis.* 2008;23:1013–1016.
16. Remzi FH, Kirat HT, Kaouk JH, Geisler DP. Single port laparoscopy in colorectal surgery. *Colorectal Dis.* 2008;10:823–826.
17. Tsimoyiannis EC, Tsimogiannis CK, Pappas-Gogos G, et al. Different pain scores in single transumbilical incision laparoscopic cholecystectomy versus classic laparoscopic cholecystectomy: a randomized controlled trial. *Surg Endosc.* 2010;24:1842–1848.
18. Choi SI, Lee KY, Park SJ, Lee SH. Single port laparoscopic right hemicolectomy with D3 dissection for advanced colon cancer. *World J Gastroenterol.* 2010;16:275–278.
19. Waters JA, Chihara R, George VV. Laparoscopic colectomy: does the learning curve extend beyond colorectal surgery fellowship? *JSLS.* In press.
20. Reichenbach DJ, Tackett AD, Harris J, et al. Laparoscopic colon resection early in the learning curve what is the appropriate setting? *Ann Surg.* 2006;243:730–737.
21. Hewett, PJ, Allardyce RA, Bagshaw PF, et al. short-term outcomes of the Australasian randomized clinical study comparing laparoscopic and conventional open surgical treatments for colon cancer: the ALCCaS trial. *Ann Surg.* 2008;248:728–738.
22. Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med.* 2004;350:2050–2059.
23. Kirchhoff P, Dincler S, Buchmann P. A multivariate analysis of potential risk factors for intra- and postoperative complications in 1316 elective laparoscopic colorectal procedures. *Ann Surg.* 2008;248:259–265.
24. Senagore AJ, Delaney CP, Brady KM, Fazio LW. Standardized approach to laparoscopic right colectomy: outcomes in 70 consecutive cases. *J Am Coll Surg.* 2004;199:675–679.
25. Veldkamp R, Kuhry E, Hop WC, et al. Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomised trial. *Lancet Oncol.* 2005;6:477–484.
26. Guillou PJ, Quirke P, Thorpe H, et al. (2005). Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet.* 2005;365:1718–1726.
27. Franks PJ, Bosanquet N, Thorpe H, et al. Short-term costs of conventional vs laparoscopic assisted surgery in patients with colorectal cancer (MRC CLASICC trial). *Br J Cancer.* 2006;95:6–12.