CHAPTER

Comparison of short-term surgical outcomes after single-incision laparoscopic versus multiport laparoscopic right colectomy

A two-centre, prospective case-controlled study of 100 patients.

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ABSTRACT

Background
Recent case studies have demonstrated the feasibility of single-incision laparoscopic colectomy (SILC). Few comparative studies for SILC and multiport laparoscopic colectomy (MLC) have been conducted. The aim of this case-controlled study was to compare the short-term surgical outcomes between SILC and MLC for right-sided colectomies.

Methods
Between January 2010 and February 2012, data from the first 50 consecutive patients that underwent right SILS at one of the two institutions were compared with a group of 50 consecutive patients that underwent right MLC in the same period.

Results
Median operative time was significantly shorter in SILC (97 vs. 112 minutes; p < 0.001). Between both groups, no statistically significant differences were found regarding number and nature of short-term complications, number of reoperations [4 (8 percent) vs. 6 (12 percent)], and mortality rate [1 (2 percent) vs. 2 (4 percent)]. Median postoperative hospital stay was 6 days for both groups.

Conclusions
SILC is a safe and feasible procedure when performed by experienced laparoscopic surgeons. Length of hospital stay and overall complication rates are comparable with MLC. Until today, no clear advantages of SILC over MLC have been demonstrated. However, due to its smaller incisional trauma, SILC could be a major step in improving cosmetic outcomes.
INTRODUCTION

Laparoscopic surgery is the standard therapy for a wide range of colonic diseases. Several randomised trials have clearly demonstrated its benefits compared to open surgery in short-term outcomes. These advantages included improved pain management, faster recovery of bowel function, reduced wound-related complications, shorter hospital admission, and improved cosmetic results.\(^1\)\(^-\)\(^10\) Long-term outcomes proved to be equal to open surgery, some studies even suggesting better oncological results.\(^10\)\(^,\)\(^11\)

To further reduce both incisional trauma and postoperative pain, single-incision laparoscopic surgery was introduced in the 1990s. This type of surgery permits operations to be performed entirely through one extraction site, generally through an umbilical incision.\(^12\)

Single-incision laparoscopic surgery was first applied to appendectomy and cholecystectomy. Even though it proved to be a safe technique, most surgeons consider it a relatively difficult approach.\(^13\),\(^14\) For that reason, its application to more advanced surgery is still limited.

In 2008, Remzi et al. described the first single-incision laparoscopic right colectomy (SILC) in humans.\(^15\) Ever since, various retrospective case studies have demonstrated the feasibility of the single-incision procedure in colorectal surgery.\(^10\),\(^15\)\(^-\)\(^22\) In recent years, the experience with SILC has grown, and surprisingly most surgeons experienced in single-incision laparoscopic cholecystectomy consider SILC relatively easier to perform than single-incision laparoscopic cholecystectomy.

Despite these publications, the widespread acceptance of this procedure has been limited. Recurrent discussion topics are a potential prolonged learning curve, compromised exposure or visualisation, increased operative time, and oncological outcome.\(^23\),\(^24\) The aim of this study was to compare the short-term surgical outcomes between right SILC and right multiport laparoscopic colectomy (MLC).

METHODS

Patient selection

Between January 2010 and February 2012, patients in whom a laparoscopic right colectomy was indicated either at Gelderse Valleil hospital (Ede, The Netherlands) or Jeroen Bosch hospital (’s-
Hertogenbosch, The Netherlands) were given the possibility to either undergo surgery according to the single-incision or to the multiport laparoscopic approach. We compared the first 50 consecutive patients who underwent right SILC with a control group of 50 consecutive patients who underwent right MLC.

Both multiport and single-incision laparoscopic procedures were conducted or supervised by the same group of surgeons, 2 and 3 experienced laparoscopic surgeons at Gelderse Vallei hospital and Jeroen Bosch hospital, respectively.

All surgeons had performed at least 50 single-incision laparoscopic procedures before performing right SILC. Both benign and malignant surgery indications were included, including carcinomas which were preoperatively suspicious for T4 carcinomas on computerised tomography. Within this study period, no elective open colectomies were performed.

Prior to the start of the study, approval was obtained from the institutional review boards of both institutions. Both institutions applied perioperative care according to the Enhanced Recovery after Surgery protocol.25

Patient data and outcomes for SILC and MLC were recorded in a prospective database and were subsequently compared to each other. Preoperative patient data comprised age, sex, body mass index (BMI), indication for surgery and the presence of previous abdominal surgery. As a measure of patient comorbidity, the American Society of Anaesthesiologists (ASA) classification was included.

In the setting of malignancy, tumour staging was assessed and reported by the use of the TNM classification system (Union for International Cancer Control, Geneva, Switzerland). Furthermore, length of specimen, tumour size, margin status and number of lymph nodes harvested (as defined in the pathology report) were acquired. Operative time, defined as time from first skin incision to completion of closure, and conversion were also obtained. Ultimately, short-term postoperative outcomes were evaluated, including duration of hospital stay, complications, the number of reoperation and mortality rate.

**Surgical technique**

The executed MLC technique was a standard three-port technique, earlier described by Veenhof et al.26

For right SILC, the patient is placed in the supine position and tilted to the left. The left side of the patient is the working area for the surgeon and the assistant, the latter holding the camera at the
head of the patient. Following infiltration with bupivacaine 0.25%, the umbilicus is thoroughly disinfectected, everted and opened longitudinally with a 3-cm incision through the skin and fascia. A wound protector is placed and the single-incision port is introduced. A pneumoperitoneum is created after insertion of the trocars. A standard 10-mm 30° laparoscope is used, as well as a straightatraumatic grasper and a 5-mm LigaSure (Covidien, Mansfield, Mass., USA). All procedures were performed using the SILS port by Covidien (Covidien, Mansfield, Mass., USA) or the TriPort by Olympus (Olympus, Hamburg, Germany). These flexible ports have, respectively, three and four access ports, which can be used for 5- and 12-mm trocars and a separate insufflation attachment, plus desufflation attachment with the TriPort. During dissection, the grasper and LigaSure device change ports to ensure the best angle.

The patient is first placed in reversed Trendelenburg position. The hepatic flexure is mobilised from medial to lateral by opening the omentum at the proximal colon transversum. Subsequently, the attachments and the lateral peritoneal reflexion of the flexure are divided. Hereafter, patient’s position is changed to Trendelenburg, and the terminal ileum is lifted. An opening is made in the mesentery, and the small bowel is divided using endostaplers (Tri-Staple Technology, Covidien, Mansfield, Mass., USA). The dissection then occurs in a medial to lateral approach. The coecum is lifted, and the mesentery is divided up to the basis of the ileocoelic artery. The ileocoelic vessels are divided using LigaSure. The retroperitoneal plane is developed until the duodenum is identified. The lateral peritoneum is opened, and the mesentery is divided to the middle colic artery. After complete mobilisation of the right colon, both ends of the bowel are grasped and both the port and the specimen are taken out. If necessary, the incision is enlarged to a maximum of 4.5 cm for the externalisation of the colon. A hand-sutured side-to-side anastomosis is created using 3.0 PDS (Ethicon, Cincinnati, Ohio, USA). The umbilical fascia is closed using interrupted Vicryl sutures (Ethicon, Cincinnati, Ohio, USA), and the umbilicus is restored using Monocryl intracutaneous sutures (Ethicon, Cincinnati, Ohio, USA).18

Statistical analysis

Data were collected and statistically analysed using SPSS v19.0 (SPSS Inc., Chicago, Ill., USA). Numerical data are presented as means with standard deviations or as medians with ranges. Continuous variables (means, standard deviations, medians and ranges) were analysed using the independent-samples t test. Categorical (ordinal and nominal) variables were analysed using the $\chi^2$
test or the Fisher’s exact test. P-values were two-tailed. Statistical significance was accepted for p-values of < 0.05.

RESULTS

From January 2010 to February 2012, a total of 50 patients underwent right SILC at one of the two participating institutions. This group was compared with 50 patients who were operated on during the same period using the multiport laparoscopic technique. Patient characteristics are depicted in table 1. No significant differences were found between the study groups, including median BMI, ASA score, history of abdominal surgery and surgical indication. Surgery indications comprised right-sided colon carcinomas, adenomas, polyps, and Crohn’s disease. Statistical analysis showed a significant difference (p < 0.001) between SILC and MLC with respect to median operative time. As shown in figure 1, median operative time was 97 (60-148) minutes for SILC and 112 (70-225) minutes for MLC.

![Figure 1](image)

**Figure 1.** Operative time according to surgical technique

The boxplots represent sample minimum, first quartile, median, third quartile, sample maximum, outliers (○), and maximum outlier (’) concerning to operative time.

*SILS* single-incision laparoscopic surgery, *MLS* multiport laparoscopic surgery
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Table 1. Patient’s demographics

<table>
<thead>
<tr>
<th></th>
<th>Laparoscopic right colectomy</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SILC</td>
<td>MLC</td>
</tr>
<tr>
<td>No. of patients</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Age in years (mean ± SD)</td>
<td>73 ± 13.2</td>
<td>71 ± 11.8</td>
</tr>
<tr>
<td>Gender, n (%):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21 (42.0)</td>
<td>22 (44.0)</td>
</tr>
<tr>
<td>Female</td>
<td>29 (58.0)</td>
<td>28 (56.0)</td>
</tr>
<tr>
<td>Median BMI (range)</td>
<td>25 (20-32)</td>
<td>25 (20-36)</td>
</tr>
<tr>
<td>ASA score, n (%):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2</td>
<td>40 (80.0)</td>
<td>43 (86.0)</td>
</tr>
<tr>
<td>&gt;3</td>
<td>10 (20.0)</td>
<td>7 (14.0)</td>
</tr>
<tr>
<td>History of abdominal surgery, n (%):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 (22.0)</td>
<td>15 (30.0)</td>
</tr>
<tr>
<td>Surgical indications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malignant disease, n (%):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ascending colon</td>
<td>41 (82.0)</td>
<td>40 (80.0)</td>
</tr>
<tr>
<td>adenocarcinoma</td>
<td>27</td>
<td>23</td>
</tr>
<tr>
<td>Cecal adenocarcinoma</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Benign disease, n (%):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right colon adenoma</td>
<td>9 (18.0)</td>
<td>10 (20.0)</td>
</tr>
<tr>
<td>Right colon polyp</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Data are numbers with SD (standard deviation), percentages or ranges in parentheses unless otherwise indicated

SILC single-incision laparoscopic colectomy, MLC multiport laparoscopic colectomy
BMI body mass index (kg/m²), ASA American Society of Anaesthesiologists
* Independent-Samples T test, † Chi-square test

Conversion to multiport laparoscopic surgery took place in 2 patients (4 percent) of the SILC group because of severe adhesions. Neither in the SILC group, nor in the MLC group conversion to open surgery was necessary (table 3). In all patients operated on for benign colon disease, the pathology report confirmed the benign preoperative surgery indication. All resections performed for malignancies had at least 10 lymph nodes harvested with a median of 14 (10-28) nodes in the SILC group and 13 (10-34) nodes in the MLC group. The surgical resection margins were all tumour negative. For malignancies, the pathology reports mainly showed T2 or T3 tumours according to the TNM classification. As depicted in table 2, malignant outcomes were statistically similar
between groups. No intraoperative complications were reported in either group. Mortality was observed in both groups and comprised one postoperative death (age 89 with significant comorbidity) in the SILC group and two in the MLC group (age 74 and 88, death due to a cerebrovascular accident and severe pneumosepsis). No significant differences were seen between groups for all postoperative outcomes, including mortality, reoperations, length of hospital stay and follow-up duration, as outlined in table 3.

Anastomotic leak occurred in 1 SILC patient, compared to 3 patients in the MLC group (2 vs. 6 percent). During follow-up, no port site hernias were observed in the SILC group, compared to 1 (2 percent) in the MLC group. Indications for reoperation included postoperative bleeding, anastomotic leak, intra-abdominal abscess (unsuitable for percutaneous radiologic drainage), and fascial dehiscence.

Median postoperative hospital stay was 6 days in both groups (range 2-41 for SILC and 2-103 for MLC). Median length of follow-up was 388 (58-772) days for SILC and 441 (69-771) days for MLC.
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Table 2. Data related to tumour pathology

<table>
<thead>
<tr>
<th></th>
<th>Laparoscopic right colectomy</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>SILC (n = 41)</td>
<td>MLC (n = 40)</td>
</tr>
<tr>
<td>Length of specimen (cm), mean ± SD</td>
<td>26.13 ± 6.9</td>
<td>25.89 ± 8.9</td>
</tr>
<tr>
<td>Histology type, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>41 (100%)</td>
<td>40 (100%)</td>
</tr>
<tr>
<td>Others</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Largest tumour diameter (cm), mean ± SD</td>
<td>4.81 ± 1.6</td>
<td>4.64 ± 1.8</td>
</tr>
<tr>
<td>Radical resection, n (%)</td>
<td>41 (100%)</td>
<td>40 (100%)</td>
</tr>
<tr>
<td>Tumour depth (T classification), n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>1 (2.4)</td>
<td>1 (2.5)</td>
</tr>
<tr>
<td>T2</td>
<td>9 (22.0)</td>
<td>3 (7.5)</td>
</tr>
<tr>
<td>T3</td>
<td>27 (65.9)</td>
<td>33 (82.5)</td>
</tr>
<tr>
<td>T4</td>
<td>4 (9.8)</td>
<td>3 (7.5)</td>
</tr>
<tr>
<td>Harvested lymph nodes, median (range)</td>
<td>14.0 (10-28)</td>
<td>12.5 (10-34)</td>
</tr>
<tr>
<td>Involved lymph nodes (N classification), n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N0</td>
<td>24 (58.5)</td>
<td>31 (77.5)</td>
</tr>
<tr>
<td>N1</td>
<td>14 (34.2)</td>
<td>7 (17.5)</td>
</tr>
<tr>
<td>N2</td>
<td>3 (7.3)</td>
<td>2 (5.0)</td>
</tr>
</tbody>
</table>

Data are numbers with SD (standard deviation), percentages or ranges in parentheses unless otherwise indicated.

SILC single-incision laparoscopic colectomy, MLC multiport laparoscopic colectomy

T classification tumour staging according to TNM classification, N classification lymph node staging according to TNM classification

*Independent-Samples T test, † Chi-square test
In recent years, a lot of research has been done to further reduce the impact of surgical trauma, resulting in new surgical techniques. By performing transgastric peritoneoscopies in porcine models, Kalloo et al. were regarded as the first to describe a natural orifice translumenal endoscopic surgery (NOTES) procedure.\textsuperscript{27} NOTES provides potential opportunities and could be
the next logical step in performing laparoscopic surgery. However, the current associated technical problems of these procedures still leads to insufficient medical guaranteed safety, resulting in slow adoption of NOTES. 28

During the development of NOTES, the single-incision laparoscopy trocar was introduced as a new ‘scarless’ approach and considered as a spin-off of all NOTES-related research. One of the most important advantages of single-port laparoscopic surgery over NOTES is the possibility to use conventional laparoscopic instruments. This has currently led to an overall greater acceptance of single-incision laparoscopic surgery than NOTES. 29-32 Various studies proved single-incision cholecystectomy to be a safe and feasible procedure. 32-35 Operative time and complications seem to be comparable with normal laparoscopy with a learning curve of around 10 to 15 procedures. 18,36-38 Even though single-incision laparoscopic surgery could have benefits compared to conventional laparoscopic surgery, particularly regarding cosmetic results, there are some technical drawbacks associated with this type of surgery. Clashing of instruments externally at the umbilicus and crossing of instruments internally makes single-incision laparoscopic surgery a challenging procedure to perform, especially in cholecystectomy and appendectomy. 39,40

We started performing SILC at the beginning of 2010, and as discussed earlier, we noticed that SILC was easier to perform than single-incision laparoscopic cholecystectomy. In our opinion, this is the result of a greater area of dissection with SILC compared to single-incision laparoscopic cholecystectomy. During dissection of the hilus in cholecystectomy, the tips of the instruments are close together, causing clashing of instruments outside the trocar. In case of a greater operation area, the tips are wider apart, which reduces clashing of the instruments outside the trocar.

Having performed several successful right SILC operations, we moved to more complex colonic procedures. Currently, at our institutions, most colorectal procedures are performed through single-incision laparoscopy. However, as we are teaching hospitals, still a lot of multiport procedures are done, mainly by senior residents.

In this article, we describe the first 50 right SILC procedures, performed in two high-volume colorectal units in the Netherlands, and compare these data to a group of 50 multiport laparoscopic right colectomies.

No significant differences were seen between the two groups, except for the operative time, which was shorter in the SILC approach. An explanation for this finding is that multiport laparoscopic procedures are frequently carried out by residents, in contrast to single-incision laparoscopic procedures, which are only performed by experienced laparoscopic surgeons.
Although calculations show a statistically significant difference between operative times, these differences are not clinically relevant. Nevertheless, SILC appears to have acceptable operative times, which in experienced hands are comparable to MLC, as proven in other studies.\(^{16,22}\) Our results show a similar number and nature of complications after right SILC and right MLC. A recent multicentre, case-controlled trial by Champagne et al. compared general SILC to MLC in a total of 330 patients (165 vs. 165), from which 234 operations (71 percent) involved right colectomies, with a similar distribution between SILC and MLC (\(p = 1.0\)).\(^{16}\) Comparable to our results, no statistically significant differences were found regarding length of hospital stay, number of reoperations, and number and nature of short-term complications. In contrast to our results, however, they found similar mean operative times of around 135 minutes between the two groups. Nevertheless, these operative times also include, for instance, left colectomies, proctectomies, and total colectomies, resulting in less reliable comparison between their and our study group.

In another recent study conducted by Adair et al., 17 patients who underwent right SILC were compared with case-matched right MLC.\(^{22}\) They measured a mean operative time of 139 minutes in right SILC and 134 minutes in right MLC, and similar short-term complications across both groups. Currently, no large randomised controlled trials or case-control studies are available to determine long-term (oncological) outcomes, port site complications, and costs. Comparable to our study, several trials concluded that single-port laparoscopic surgery is a safe and feasible surgery technique. However, no additional benefits related to this surgery technique have yet been demonstrated. Theoretically, it will be more appealing to patients because of better cosmetic results, compared to multiport laparoscopic surgery.\(^{10,15-22}\)

Our research group recently sent questionnaires, including body image questionnaires, to female patients after having a cholecystectomy through a multiport or single-incision laparoscopic, or hybrid transvaginal approach. The results showed a strong prevalence for single-port laparoscopic and transvaginal cholecystectomy. Whether this cosmetic advantage is relevant in patients operated on for cancer remains unclear, and should be reflected in future studies.

Another future discussion point is the implementation of the single-incision laparoscopic surgery technique in the surgical training of residents. Our residents start with multiport laparoscopic surgery and progress to single-incision laparoscopic procedures.
CONCLUSIONS

In conclusion, single-incision laparoscopic surgery is a safe and feasible procedure when performed by experienced laparoscopic surgeons. Length of hospital stay and overall complication rates are comparable with multiport laparoscopic surgery. Whether the suspected reduction in surgical trauma will result in clinically relevant benefits remains to be proven. Single-incision laparoscopic surgery could be a major step in improving cosmetic outcomes and could therefore potentially increase overall postoperative patient satisfaction.
REFERENCES