Single port laparoscopic surgery for patients with complex and recurrent Crohn's disease

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Single incision laparoscopy; Minimal access surgery; Inflammatory bowel disease; Crohn's disease; Ileocolic resection

Abstract

Background: Single port laparoscopic surgery (SPLS) is a modified access technique allowing grouping of instruments at a single parietal site. It is intuitively appealing specifically for patients with Crohn's disease (CD) as its minimal invasiveness favors cosmesis and facilitates any future (re)operation.

Methods: Consecutive patients presenting either electively or urgently for resectional surgery for CD over a 36 month period were considered for SPLS using, by preference, a transumbilical 'Surgical Glove Port'. Standard, straight laparoscopic instrumentation was used without additional resources.

Results: Of 33 consecutive, unselected patients, 28 (92%) had their procedure initiated by SPLS including those needing urgent intervention (n = 15) and those with prior abdominal operation (n = 8), obstruction (n = 7), mass (n = 6), fistula (n = 6) and/or abscess (n = 4). The median (range) age and BMI of the patients were 31 (17–69) years and 21.3 (18.6–28) kg/m² respectively. 31 had ileocolonic resection (6 with recurrent disease) while two underwent segmental colectomy. No-one suffered intraoperative or anastomotic complication. Both conversion (15%) and postoperative complication (13 Clavian–Dindo complications – I: 8; II: 2; IIIa: 3) rates were predominantly reflective of patient and disease complexity. Median (range) postoperative day of discharge was 6 (3–33) overall and 5 (3–18) in those completed by SPLS. There was one early readmission (for infectious colitis) and median follow-up is now 21 months.

Conclusions: Complex and recurrent Crohn's resections can be performed by SPLS in the majority of patients presenting elective or urgently for surgery. The Surgical Glove Port performs capably and, by minimizing cost, can facilitate broad embrace of this approach.

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1. Introduction

Single port laparoscopic surgery (SPLS) is a recent modified access operative technique that allows grouping of laparoscopic instrumentation at a single confined site in the abdominal wall in order to further minimize the degree of parietal wounding associated with intraperitoneal surgery. Given that resectional intestinal surgery mandates an extraction site that anyway approximates the diameter of current single port devices, this category of operation fits well with the concept and practice of this evolving modality. To date, analyses of SPLS for colorectal disease have predominantly focused on feasibility and technical adequacy in the elective setting as it relates to early stage, neoplastic disease.\(^1,2\)

However, patients with Crohn’s disease (CD) represent another major proportion of those undergoing resectional colorectal surgery and seem the cohort more likely to benefit from the technical advance of SPLS.

Firstly, the majority of these individuals are young and so tend to have heightened appreciation of body image issues.\(^3,4\) Furthermore, they may psychologically appreciate the effort regarding minimal scarring especially perhaps as surgery is often considered ‘therapeutic failure’ in this disease including by physicians. Many also will need their surgery performed at a time when they are physically and immunologically debilitated without a capacity for preoperative normalization and so have an impaired capacity for wound healing. Many such patients will also need further surgery in their future for either disease recurrence or indeed any other intra-abdominal pathology requiring surgery that might develop over subsequent decades of life. Preservation of the majority of the abdominal wall to facilitate peritoneal access at any future operation along with the minimization of postoperative peritoneal adhesion extent should therefore be an advantage.

Finally, these patients are often slim and have not previously stretched onto the outer ring of a wound protector

all were fully consented regarding the procedure including the means of operative access. Those suitable for a laparoscopic operation were offered the single port approach for its initiation and assured a low threshold for conversion to a standard multiport laparoscopic operation or open surgery as may be required. Those likely to need stoma formation were appropriately counseled prior to surgery and marked for optimal stoma site by a Specialist Nurse Practitioner. All operations were performed by a single surgical team working in a tertiary referral center without specific additional resource provision in terms of either theater capacity or equipment. The procedures were performed either by the Senior Resident/Registrar alongside the scrubbed consultant as camera operator or shared between the two depending on procedure circumstance, difficulty and duration as is our usual practice. Patient demographics along with their clinical, laboratory, radiological and histopathological profiles were recorded prospectively on a dedicated database in addition to operative and postoperative details. Postoperative complications were categorized as by Clavien–Dindo.\(^8\)

2. Methods and materials

All patients presenting for surgical resection for pathologically confirmed or radiologically ascertained (predominantly CT and/or MRI) CD over a 36 month period (December 1st 2010 to December 31st 2013) were considered for a SPLS approach including all those requiring urgent operation. Patients needing emergency surgery were excluded from the study but still recorded in the database. Where possible all were physically and nutritionally optimized for surgery and

2.1. Single port access device

The single port access device of preference was the ‘Surgical Glove Port’. As previously described,\(^9,10\) this apparatus is constructed table-side by a single member of the surgical team after patient positioning and while operative field sterilization and draping is being performed and so is ready for use immediately at procedure commencement. In short, it comprises a standard surgical glove into which standard laparoscopic trocar sleeves (one 10 mm and two 5 mm) are inserted (without needing obturators) into three fingers cut at their tips. The ports are tied in position using strips cut from the other glove in the pair and the cuff of the ‘Glove port’ stretched onto the outer ring of a wound protector-retractor (e.g. ALEXIS™, S, Applied Medical) to ensure an air-tight seal (see Fig. 1).

2.2. Single port procedure

All patients received standard antithrombosis and antimicrobial prophylaxis and underwent general anesthesia without either epidural or spinal anesthesia. Antegrade PEG solutions for bowel cleansing were not routinely utilized. The patient was placed in a Trendelenburg position on an anti-slip beanbag. A local anesthetic block (bupivacaine) was infiltrated around the intended transumbilical incision site. A 3 cm skin and fascial incision were then measured, marked and made here. On securing safe entry into the peritoneum, the ‘Glove Port’ was established. The carbon dioxide sufflation channel was attached to one of the trocar taps and the pneumoperitoneum induced. The operation was performed using standard rigid laparoscopic instruments, generally a 10 mm 30° high definition laparoscope with an in-line sterile optical cable (Endoeye™, Olympus Corporation) along with an atraumatic grasper and either a laparoscopic scissors or, most often and solely, an energy sealing/dissector device (Ligasure, Covidien).

Segmental resections were performed by a standardized medial to lateral approach focusing on the main arterial
supply. Although mesenteric and mesocolic preservation is possible and indeed preferred for benign diseases, the presence of bulky lymphadenopathy in CD may still encourage operation along anatomic planes with proximal vessel ligation. For right sided resections, the duodenum was identified early, ahead of vessel ligation while, for left sided mobilization, an inferior mesenteric vein first approach to the splenic flexure was chosen before entry into the lesser sac and lifting of the splenic flexure mesocolon from the pancreas without encroachment onto the marginal artery. In cases of redo operations for recurrent disease, an initial lateral mobilization of the pathology site (usually the prior anastomosis) may be preferred. Thereafter, the omentum was taken from the transverse colon and full lateral mobilization of either the terminal ileum or descending and sigmoid colon is achieved. Mesenteric/mesocolic dissection was performed towards the vescus intracorporeally. The specimen was delivered to the exterior through the wound protector (after removal of the sealing Glove port) and the resection and stapled anastomosis performed extracorporeally in the usual fashion. The bowel was then returned to the peritoneum and re-laparoscopy performed to ensure hemostasis and perform lavage if required. The fascia and skin were closed with absorbable sutures (0 loop polydioxanone and 3/0 poliglecaprone). Bilateral Transversus Abdominis Preperitoneal Plane (TAPP) blocks were used with or without an infusional catheter (Painbuster, B-Braun) tunneled to irrigate bupivacaine directly into the wound postoperatively.

2.3. Postoperative management

Patients (both elective and urgent) were managed postoperatively within our formalized enhanced recovery protocol. Nasogastric tubes were routinely removed at procedure-end and patients were mobilized within the first 6–12 h of surgery. Oral intake was commenced on demand and built up steadily as tolerated thereafter. Urinary catheters were removed on the first postoperative day.

2.4. Ethical considerations

Departmental approval was achieved before commencement of the experience. The technique of SPLS is not experimental as it is simply a variation of standard multiport laparoscopy and has been already proved valid and feasible by prior experience in this hospital as well as others. All patients were fully consented regarding the approach and informed of the conventional alternatives. All were assured a
low threshold for conversion if any deviation from operative plan was encountered.

3. Results

Over the thirty six month study period, 39 patients with CD presented for surgery. Three patients were acute emergencies (two had free intraperitoneal perforations with toxemia and one had a closed-loop megacolic obstruction) and underwent their surgery by laparotomy ab initio. The remaining 36 patients (92%) had surgery on an urgent or elective basis. Three of these patients had previously undergone major laparotomy with segmental colectomy with one having a large incisional hernia requiring synchronous repair while two others (one morbidly obese) had synchronous recurrent ileocolic and separate colonic CD with chronic pelvic abscesses and enterovesical fistu- lae. These patients also had open operations.

Thirty three patients (92% of those undergoing elective or urgent operation) were judged suitable for laparoscopic surgery in the initial access modality. 31 (94%) had prior abdominal surgery and all were commenced by single port access (see Table 1 for patient profiles). 31 (94%) had surgery on an urgent or elective basis. Three of these patients (19%) had previously undergone ileocaecal resection (four via midline laparotomy). Two patients had colonic strictures treatable by segmental colectomy. Fifteen patients needed urgent procedures. Overall, co-morbidity was low. Twenty eight out of the thirty three patients (85%, including four of the six redo cases) started with a single port approach had the intra-abdominal component of their operation completed entirely via this access modality without any additional trocars being required including the majority of those with previous surgery, recurrent disease, obstruction, mass, fistula and abscess (see Table 2). Four of these patients (15%) however did require extension of their access site simply for the purpose of specimen extraction. All 28 had a primary anastomosis performed extracorporally (26 ileocolic and two colocolonic anastomoses). Median time to first passage of flatus per rectum was 16 h and the median postoperative length of stay was 5 days (our mean length of stay for CD resections in 2010 was 8 days).

Five operations were converted to laparotomy, two very soon after procedure commencement (one due to dense adhesions secondary to three previous open resections and one because of complex fistulating disease with closed loop obstruction). The remaining three had significant mobilization achieved laparoscopically via the single port access but were thereafter converted to ensure safe and efficient

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Cohort overall (n = 33)</th>
<th>Ileocolonic disease (n = 31)</th>
<th>Colonic disease (n = 2)</th>
<th>Primary ileocaecal resection (n = 25)</th>
<th>Redo ileocolonic resection (n = 6)</th>
<th>Completion by SPLS (n = 28)</th>
<th>Converted to laparotomy (n = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (range) in years</td>
<td>31 (17–69)</td>
<td>30 (17–69)</td>
<td>42.5 (36–49)</td>
<td>30 (17–69)</td>
<td>45.5 (24–69)</td>
<td>31 (17–69)</td>
<td>48 (20–69)</td>
</tr>
<tr>
<td>Mean BMI (range) in kg/m²</td>
<td>21.3 (18.6–28.0)</td>
<td>21.8 (18.6–19.3)</td>
<td>21.8</td>
<td>22 (21–23.7)</td>
<td>21.5 (16–24)</td>
<td>22.0 (16–24)</td>
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<tr>
<td>Urgent procedure</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>6 (3–18)</td>
<td>14 (8–33)</td>
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<tr>
<td></td>
<td>Conversion rate (%)</td>
<td>5/33 (15%)</td>
<td>5/31 (16%)</td>
<td>4/33 (12%)</td>
<td>3/25 (12%)</td>
<td>2/6 (33%)</td>
<td>5/0 (100%)</td>
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<td></td>
<td>Wound extension rate (%)</td>
<td>4/33 (12%)</td>
<td>4/31 (13%)</td>
<td>4/25 (16%)</td>
<td>4/25 (16%)</td>
<td>4/28 (14%)</td>
<td>0/5 (0%)</td>
</tr>
<tr>
<td></td>
<td>Mean Operative time (range) in min</td>
<td>120 (80–200)</td>
<td>120 (80–200)</td>
<td>155 (150–160)</td>
<td>120 (80–200)</td>
<td>120 (80–180)</td>
<td>150 (80–200)</td>
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<td></td>
<td>Median postop day of discharge (range)</td>
<td>6 (3–33)</td>
<td>6 (3–33)</td>
<td>5 (5–5)</td>
<td>6 (3–23)</td>
<td>4.5 (3–33)</td>
<td>5 (3–18)</td>
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<td></td>
<td>Median resection specimen length (range) in mm</td>
<td>280 (120–1005)</td>
<td>280 (120–1005)</td>
<td>310 (230–380)</td>
<td>365 (130–1005)</td>
<td>195 (120–35)</td>
<td>270 (120–560)</td>
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<td></td>
<td>Microscopic margin involvement (%)</td>
<td>6 (18%)</td>
<td>5 (16%)</td>
<td>1 (50%)</td>
<td>4 (16%)</td>
<td>1 (17%)</td>
<td>5 (18%)</td>
</tr>
<tr>
<td></td>
<td>Complication by Clavien–Dindo classification</td>
<td>13</td>
<td>12</td>
<td>1</td>
<td>7</td>
<td>6</td>
<td></td>
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</table>

Class I complication: A, pain investigated by CT scan; B, wound infection.
Class III complications: A, Collection requiring radiological drainage; B, Postop peptic ulcer.
completion of surgery. Four of the converted patients had required total parenteral nutrition preoperatively due to severe malnutrition and all five operations were planned and predictably difficult and each concluded with an ileostomy (two stoma being proximal to additional downstream anastomoses). Interestingly, all were converted straight to laparotomy without multipor laparoscopy as an interim step. There were no significant patient demographic or operative duration differences with conversion but there was a significantly longer median postoperative stay (p = 0.001, Mann Whitney U).

There were a total of 13 Clavien–Dindo complications. There were no anastomotic leaks (including the 28 patients with unprotected primary anastomosis) or need for postoperative intensive care admission or reoperation. Two patients of the cohort completed laparoscopically had significant ileus requiring postoperative nasogastric tube insertion while five had superficial wound infections. Two other patients had pain investigated by CT imaging postoperatively (done with low threshold and reassuring in each case). Two patients with ileostomy required intermediate-term pharmacological therapy for high output. Two patients developed postoperative collection requiring radiological drainage while another had severe bleeding postoperatively from a duodenal peptic ulcer that required radiological embolization after a failed initial attempt at endoscopic control. One patient was readmitted with Clostridium difficile diarrhea. Mean follow-up time is 21 months (range 1–38) and there have been no late wound herniations. Informally, patients in the SPLS-completed group view their incisions favorably (see Fig. 2).

Economically the cost of the glove port per case was $89/€55. Importantly, while much cheaper than commercially available single port devices, this is cheaper than a standard multiport approach as only trocar sleeves (without obturators) are needed. Thus, using disposable ports at list-price, a saving of $80/€55 per laparoscopic-assisted segmental resection is achieved. Of course, the cost saving is even greater when reusable ports are used (use of this technique even avoids re-sharpening costs). No specialized instruments were used and therefore there were no added costs above that incurred for the multiport equivalent (the wound protector—retractor used at the beginning of the case would otherwise be used anyway at the time of specimen extraction). Also as there was no loss of theater efficiency or significant increase in theater over-run (or indeed reduction) and therefore no separate costs were accrued (or saved) in this respect.

4. Discussion

It is only relatively recently that multiport laparoscopy has been demonstrated advantageous for patients with CD and still this service is often only provided relatively selectively especially in the acute setting and when complex disease is present. Although evolving with regard to surgeon expertise and technological refinement, the technique of SPLS may be a further step advance particularly useful for these individuals who are often slim, young and lack previous laparotomy and have most often clearly definable, regional disease. While natural orifice specimen extraction techniques are evolving, the requirement for an abdominal incision to facilitate specimen removal for patients undergoing intestinal resection is likely to remain common practice in most units over the next few years. SPLS allows surgeons performing these procedures to utilize this surgical incision site as the only point of transabdominal access and obviate any extra port sites in the majority of cases.

Although the morbidity associated with perfectly placed, 5 mm internal diameter trocars is considered minimal (trocar-related complications occur with a frequency of approximately 1%), large intestinal surgery usually requires a stapler and/or clip appliers mandating at least one non-optical 12 mm port, a diameter more associated with adverse impact including discomfort, infection and herniation. Furthermore, the sole site of abdominal wounding in SPLS is confined to one small parietal area, a factor that favors effective local postoperative analgesic techniques in place of regional anesthesia and systemic opiates. It should also minimize long-term complications including intraoperative adhesion formation which can both lead to patient discomfort and morbidity and confound re-operation. Finally, and perhaps most importantly, the cosmetic advantage of a well placed, single site incision has now been established and is likely to prove appealing and possibly even comforting to a young individual facing major surgery. This is a point of distinction between patients with CD and the, more usually older, patients with cancer who (along with their families) are generally quite unconcerned with marginal cosmetic advantage.

Although already demonstrated feasible for colorectal surgery in general, some experts still feel that SPLS is undermined by the current expense of the commercially available devices. Our choice of access port obviates this issue. In addition, the trocars are placed into the extracorporeal glove space eliminating the risk of visceral or vascular injury. However the main advantage of this innovative access modality is its performance which, in our experience, is better than any commercial equivalent by virtue of its elasticity and backlash, mobile fulcrum point (permitting enhanced horizontal, vertical and rotational maneuverability as well as augmented instrument tip ab/adduction and triangulation) while being every bit as stable and durable. Furthermore, the device is always available (without pre-purchasing), applicable to every patient regardless of body wall depth (due to the
adaptable wound protector–retractor component) and induces minimal financial penalty if conversion to a multiport or open operation is required. One final advantage we have found is that the access incision used (3 cm) in fact represent a safer means to enter a previously operated or otherwise hostile abdomen in that it is, in effect, a minilaparotomy that is then sealed to allow laparoscopy.23 We view this as preferential to off-midline blind-stab incisions or indeed redo open Hassan access at a scarred umbilicus which may have sub-adherent omentum or intestine.

Of course, parietal access is only one component of the surgical address of CD and we have ensured that the intra-abdominal component of the operation replicates the multipoint equivalent in being safe, reproducible and standardized. There is no compromise with respect to mobilization, dissection or anastomosis construction and there are no promises made to the patient that operative access be prioritized over the quality of the intra-abdominal operation. We have also continued to maintain our training obligations as a university center and trainees are included in the usual graded, supervised fashion. Furthermore, we have found no significant change in our theater list efficiency or use patterns and have been able to incorporate the technique without any extra service or resource allocation. Although these cases may present inconveniently and may not be schedulable, surgeons should employ minimally invasive techniques that benefit the patient and advantage the health-care provider.

This series, to our knowledge, represents the single largest sequential cohort experience focused solely on patients with CD to date.24 By commencing cases on a consecutive basis (in the absence of a clear contraindication to laparoscopy), selection bias was avoided and disease complications such as fistulation, obstruction and abscesses (which others have excluded ab initio5,7 and which only have been previously reported exceptionally25,26) were included so reflecting routine practice. The majority of cases could be completed by SPLS alone although, interestingly, all those not so concluded were completed by laparotomy. This is a point of distinction between other groups who have found recourse to multiport laparoscopy useful in a minority of cases and perhaps reflects our expertise in single port laparoscopy. We view the facilitation of straight conversion to an inline laparotomy (especially in patients predictable as likely needing open surgery) as a further benefit to a single access commencement strategy as it avoids off-midline ports which may be morbidity and a nuisance to close. The lack of contemporaneous control group is a potential weakness although the results are broadly consistent with other groups’ experiences which have very capably already addressed comparative analysis (albeit with homogeneity and selectivity). The confined access approach may perhaps mean that small skip lesions could be overlooked in atraumatically but this risk is minimized by modern preoperative radiological assessment27 and the ability to palpate the proximal bowel at the time of specimen extraction.

In conclusion, SPLS represents an adapted laparoscopic access technique that can safely and effectively provide ileal and colonic resectional surgeries in the majority of patients with CD in the elective and urgent setting including those with recurrent and complex diseases. It need not be associated with increased costs either in terms of access devices or theater efficiency and seems likely to be viewed favorably by patients who include cosmesis among their priorities when considering surgical intervention for their disease.

Conflicts of interest

The authors have no conflicts of interest to declare. Each author has contributed substantially to this study and manuscript including the conception and design of the study as well as the acquisition, analysis and interpretation of data and the drafting and revisions of the article. All have approved this final version for submission.

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