

# Single incision glove port laparoscopic colorectal cancer resection

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## ABSTRACT

**INTRODUCTION** The advantages of single port surgery remain controversial. This study was designed to evaluate the safety and feasibility of single incision glove port colon resections using a diathermy hook, reusable ports and standard laparoscopic straight instrumentation.

**METHODS** Between June 2012 and February 2014, 70 consecutive patients (30 women) underwent a colonic resection using a wound retractor and glove port. Forty patients underwent a right hemicolectomy through the umbilicus and thirty underwent attempted single port resection via an incision in the right rectus sheath (14 high anterior resection, 13 low anterior resection, 3 abdominoperineal resection).

**RESULTS** Sixty-two procedures (89%) were completed without conversion to open or multiport techniques. Four procedures had to be converted and additional ports were needed in four other patients. The postoperative mortality rate was 0%. Complications occurred in six patients (9%). Two cases were R1 while the remainder were R0 with a median nodal harvest of 20 (range: 9–48). The median length of hospital stay was 5 days (range: 3–25 days) (right hemicolectomy: 5 days (range: 3–12 days), left sided resection: 6 days (range: 4–25 days). At a median follow-up of 14 months, no port site hernias were observed.

**CONCLUSIONS** Single incision glove port surgery is an appropriate technique for different colorectal cancer resections and has the advantage of being less expensive than surgery with commercial single incision ports.

## KEYWORDS

Single port – Glove port – Laparoscopic surgery

Accepted 4 October 2014

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Minimally invasive surgical techniques have revolutionised the patients' surgical experience and are becoming common practice. Single incision laparoscopic surgery (SILS) has evolved naturally from the clear benefits associated with laparoscopic surgery<sup>1,2</sup> but the advantages of single port surgery remain controversial. The impact of single port surgery on hospital stay, postoperative complications, recovery of bowel function, improved cosmesis and incisional hernia formation are yet to be defined. There is a paucity of published data in respect of single incision laparoscopic colectomy for cancer and those studies that are published describe a variety of single incision laparoscopic surgical techniques that focus predominately on right-sided resections.<sup>3,4</sup> This study was designed to evaluate the safety and feasibility of single incision glove port colonic cancer resections using a diathermy hook, reusable ports and standard laparoscopic straight instrumentation.

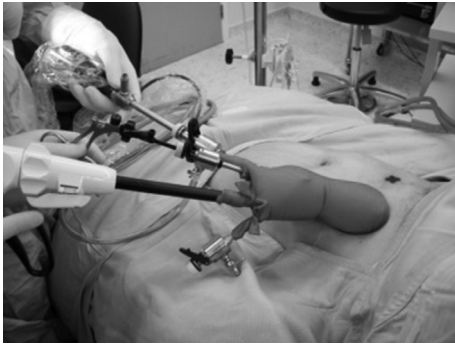
## Methods

Consecutive patients undergoing single incision glove port colonic cancer resections between June 2012 and February

2014 were reviewed in our prospectively collected database. No selection took place on the basis of body habitus or previous abdominal surgery. All procedures had direct operative involvement of surgical trainees and fellows. Factors evaluated were patient demographics (age, sex and weight), diagnosis, duration of surgery, intra and postoperative complications, recovery of bowel function, measurable tumour size, incision length, length of bowel resection, estimated blood loss, use of curved instruments, duration of operation, drain placement, pain score and length of hospital stay. Preoperative mechanical bowel preparation was given to all patients but not to those undergoing right hemicolectomy, who alternatively received 24 hours of clear fluids.

## Glove port technique

Single port surgery was performed with a self-made glove port system. In brief, the system was constructed by connecting a commercial wound protector (Alexis® wound retractor system; Applied Medical, Rancho Santa Margarita, CA, US) to a surgical glove. Reusable trocars (eg 5mm,



**Figure 1** Glove port technique showing cross stapling of the rectum in a high anterior resection with introduction of the stapler without use of a port

10mm, and 15mm) were introduced through the little finger, thumb and middle finger of the glove respectively (Fig 1). The standard trocars used were 10mm for the camera held by the assistant and two 5mm ports for the surgeon. When stapling was required (eg with a low anterior resection for bowel transection), this was performed using a laparoscopic stapler introduced along a finger of the glove without the use of a port. During this stapling, the instruments used were a 10mm camera via a trocar, a 12mm laparoscopic stapler in the glove without a port and a laparoscopic retractor via a 5mm trocar. Following transection, the stapler was removed and the 5mm port replaced.

The double ring design of the wound protector allows not only the wound protector and surgical glove to be connected tightly but also the glove to roll completely around the wound protector without air leakage. The device allows a larger range of movement, better wound care protection and more feasibility of direction change at anytime. Furthermore, it is suitable for all body types.

### Surgical procedure

Under general anaesthesia, patients were placed in the lithotomy or supine position. An incision of 2–3cm was made at the umbilicus in patients undergoing a right hemicolectomy. For high anterior resections, this incision was made in the left rectus sheath and splenic flexure mobilisation was standard. For low anterior resections, the glove port was inserted via the eventual ileostomy site, making the surgery ‘incisionless’. Splenic flexure mobilisation was standard. For abdominoperineal excisions of the rectum, the patient was marked preoperatively for a colostomy on the right side and this site was used for the glove port. In order to facilitate a tension free right-sided colostomy, the splenic flexure was mobilised in these cases. The perineal part of the procedure was performed with the patient prone, in an extralevator fashion. The specimen was delivered through the perineal wound, making the surgery ‘incisionless’. Splenic flexure mobilisation was routine for left-sided resections generally.

The glove port with the wound protector system was placed and a carbon dioxide pneumoperitoneum was produced with a maximal pressure setting of 12mmHg. A 30° 10ml laparoscope was used for all patients. Dissection was undertaken using a diathermy hook. Named vessels were clipped using Hem-o-lok® clips (Teleflex, Wayne, PA, US). The Endo GIA stapling device (Covidien, Dublin, Ireland) was used for bowel transection in left-sided restorative operations. All patients who underwent a low anterior resection received a temporary ileostomy.

### Postoperative care

All patients received standard postoperative and pain management. Visual analogue pain scores were recorded on the first operative day. If drains were placed, then they were removed when the recorded drainage was <50ml per day. Patients were treated as per the trust’s enhanced recovery protocol. Return of bowel function was defined as the passage of flatus. When tolerating a general diet, patients were discharged (typically on postoperative day 5–7) and subsequently followed up in the outpatient clinic.

### Statistical analysis

Comparability of demographic data and clinical outcomes among these groups was tested using the chi-squared test for categorical variables and one-way analysis of variance for continuous variables. A *p*-value of <0.05 was considered statistically significant. Statistical analyses were performed using SPSS® version 15.0 (SPSS, Chicago, IL, US).

### Results

Seventy consecutive patients (30 women) underwent a colon resection using a wound retractor and glove port. Forty patients underwent a right hemicolectomy through the umbilicus. Thirty patients underwent attempted single port resection via an incision in the right rectus sheath (14 high anterior resection, 13 low anterior resection, 3 abdominoperineal resection). Four procedures had to be converted because of a bulky tumour (*n*=3) or adhesions (*n*=1). Additional 5mm ports were needed in four other patients.

Sixty-two procedures (89%) were completed without conversion to open or multiport techniques. The characteristics of these patients are shown in Table 1. The median operative time was 165 minutes (range: 65–240 minutes) for patients undergoing a right hemicolectomy and 255 minutes (range: 165–435 minutes) for patients undergoing left-sided resection (*p*<0.01). The median blood loss was 40ml (range: 10–300ml).

The median skin incision for patients undergoing a right hemicolectomy was 5.7cm (range: 4.0–11.0cm) and 6.4cm (range: 5.0–12.0cm) for patients undergoing anterior resection. This increased length of incision reflected the enlargement of the wound for specimen extraction. The mean pain score after one day was 1.9 (range: 0–7) at rest in patients after a right hemicolectomy and 4.6 (range: 0–9) during movement. The mean pain score at rest on postoperative day 1 after an anterior resection was 2.3 (range: 0–6) and it was 4.0 (range: 1–7) during mobilisation.

**Table 1** Patient characteristics

	Right hemicolectomy (n=37)	Anterior / abdominoperineal resection (n=25)
Median age in years	68 (range: 26–95)	68 (range: 38–87)
Male / female	60% / 40%	52% / 48%
ASA grade 1 / 2 / 3	24% / 65% / 11%	28% / 72% / 0%
Median BMI in kg/m <sup>2</sup>	25 (range: 18–39)	26 (range: 22–36)
<i>TNM classification</i>		
T1 N0	3%	4%
T2–3 N0	65%	56%
T1–3 N1–2	22%	28%
T4 N1–2	12%	12%

ASA = American Society of Anesthesiologists; BMI = body mass index; TNM = tumour, lymph nodes, metastasis

The postoperative mortality rate was 0%. Complications occurred in six patients (9%). Two patients suffered from superficial abdominal wound infections, requiring antibiotics, and one patient had breakdown of his perineal wound. One patient was treated for symptoms of a urinary tract infection and two patients had a pulmonary embolism within 30 days of surgery.

Two cases were R1 (positive high tie node within 1mm of margin and following an abdominoperineal resection that was positive anteriorly around the level of the prostate and was therefore related to the perineal [ie non-single port] part of the procedure) while the remainder were all R0 with a median nodal harvest of 20 (range: 9–48). Overall, the median length of hospital stay was 5 days (range: 3–25 days); for right hemicolectomy patients, it was 5 days (range: 3–12 days) and for left sided resections, it was 6 days (range: 4–25 days).

At a median follow-up of 14 months (range: 5–22 months), all patients were disease free. Two patients (15%) who had low anterior resection still had a temporary ileostomy. No incisional or parastomal hernias were reported. A right-sided colostomy was necessary to allow single port abdominal perineal resection. This is non-standard practice. However, no wound infection or parastomal hernias were observed during the follow-up period in this group of patients.

## Discussion

Advanced instrumentation and surgical experience has pushed the boundaries of conventional laparoscopic surgery to search for further innovative, minimally invasive procedures in the hope of improving short-term outcomes. Bucher *et al* described the first single incision access laparoscopic right hemicolectomy in 2008.<sup>5</sup> Since then, the use of single port surgery has been applied to other parts of the colon. Furthermore, several different methods of port

application have been developed. These require commercially available port systems, which are relatively expensive. From the many new port devices available, choosing the type of port device for single port surgery is the most important factor. The cost of a novel surgical procedure is a significant issue in most countries. Hayashi *et al* were the first to demonstrate the feasibility of a glove port in an abdominal surgical procedure in 2010.<sup>6</sup>

The true benefits of single incision laparoscopic colectomy are still unclear. Single incision laparoscopic colectomy poses a number of unique technical challenges for the laparoscopic surgeon. Regardless, oncologic safety is a prerequisite for applying this procedure to the treatment of colon cancer. A number of individuals have questioned the ease and safety of performing lymph node dissection – a consequence of the decreased range of motions and clashing of instruments.<sup>7</sup> Likewise, others have questioned whether single incision laparoscopic procedures could be associated with a higher incidence of port site hernias because of the increased operative time and manipulation of the fascia surrounding the single incision laparoscopic port.<sup>8</sup> In 2010 we started to use the glove port technique in patients who had required a reversal of Hartmann’s procedure; this allowed us to conduct this series without a learning curve.<sup>9</sup>

We report a large prospective case series of single incision glove port surgery. Our series demonstrates that a single incision glove port technique is feasible in the treatment of colonic cancer with results that are comparable with other studies.<sup>6,10–12</sup> Various smaller series have demonstrated the feasibility of single incision laparoscopic colectomy in terms of oncological safety and low complication rates but these groups limit the indications of the procedure exclusively to T1/T2 N0 cancers.<sup>13,14</sup>

In our non-selective series, single incision laparoscopic colectomy was found to be feasible and safe. There were two R1 resections but one of these was from an abdominoperineal excision of the rectum and the positive margin was at the anterior aspect of the prostate, which arose from the perineal approach and cannot therefore be attributed to single port surgery. Blood loss was acceptable and the cosmetic results were also favourable. In terms of postoperative pain, the amount of analgesia used was also acceptable.

A case-controlled study by Champagne *et al* in 2011 compared the outcome of laparoscopic colectomy and conventional assisted colectomy.<sup>15</sup> It showed that results of both procedures were similar except that the operative time was longer in the single incision group. In our study, the operative time was not significantly increased in patients undergoing a right hemicolectomy but it was slightly increased in patients undergoing low anterior resection. This may be due to the fact that only two instruments are available for mobilising the splenic flexure and in our series, we did not use curved instrumentation.

Recent case-controlled trials have compared general single port surgery with multiport incision procedures and found no clinically relevant differences regarding operative time or length of hospital stay.<sup>15,16</sup> The length of stay of five days in the present study is similar to our historical series. Single incision glove port colectomy appears to have

**Table 2** Studies of single port series in the literature

Study	Country	Number of cases	Conversion rate	Median LOS	Morbidity	Mortality
Present study	UK	70	11%	5 days	10%	0%
Lu, 2013 <sup>10</sup>	Taiwan	46	7%	7 days	0%	0%
Livraghi, 2012 <sup>13</sup>	Italy	2	0%	6 days	0%	0%
Ishida, 2011 <sup>14</sup>	Japan	9	11%	8 days	0%	0%
Kim, 2011 <sup>21</sup>	Korea	55	1%	10 days	32%	0%

LOS = length of stay

acceptable operative times. However, our data also show a wide range in operative times. This might be explained by patient selection and surgeon experience. In order to reduce operative times, we advocate a low threshold to convert to a multiport procedure, especially for left-sided colectomy.

### Study limitations

A limitation of our study is the short follow-up period. At a median follow-up of 14 months, no port site hernias were observed but a longer follow-up duration is required to comment on this definitively. With limited evidence available from randomised controlled trials on outcomes such as cosmesis<sup>17,18</sup> and postoperative pain,<sup>19</sup> the financial ramifications of single port surgery should not be ignored. Current laparoscopic colectomy has been shown to be cost effective largely because of a reduction in hospital stay.<sup>20</sup>

Our study shows the benefits of single port surgery in respect of reduction in pain, length of hospital stay and port site morbidity, and these are consistent with the literature (Table 2) but there is the added bonus of a low cost glove port technique, which offers an additional positive economic consideration. The glove costs 80 pence and the procedure only requires regular laparoscopic instruments. Furthermore, our cohort was unselected, consisting of a range of body mass indices and tumour stages, which suggests the technique may be easily transferable to the general population. The role of single port surgery is limited in current medical practice but it is likely to evolve over time. It will be more appealing to patients because of better cosmetic results, compared with multiport laparoscopic surgery. Moreover, using the glove port, the required instruments are the same as for regular laparoscopic surgery.

### Conclusions

Single incision glove port surgery is a suitable technique for different colorectal cancer resections, and has the advantage of cost effectiveness and easy specimen extraction. This series demonstrates that the technique is feasible and safe and that it has a favourable cosmetic outcome.

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