Incisional hernia rate after laparoscopic colorectal resection is reduced with standardisation of specimen extraction

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ABSTRACT

INTRODUCTION Incisional hernia is a common complication of laparoscopic colorectal surgery. Extraction site may influence the rate of incisional hernias. Major risk factors for the development of incisional hernias include age, diabetes, obesity and smoking status. In this study, we investigated the effect of specimen extraction site on incisional hernia rate.

METHODS Two cohorts of patients who underwent laparoscopic colorectal resections in a single centre in 2005 ($n=85$) and 2009 ($n=139$) were studied retrospectively. In 2005 all specimens were extracted through transverse muscle cutting incisions. In 2009 all specimens were extracted through midline incisions. Demographic variables, rate of incisional hernias and risk factors for hernia development were compared between the year groups. All patients had been followed up clinically for two years.

RESULTS A total of 224 patients (mean age: 67.5 years, standard deviation: 16.35 years) were included in this study. Of these, 85 patients were in the 2005 transverse group and 139 were in the 2009 midline group. The total incisional hernia rate for the series was 8.0% at the two-year follow-up visit. For the 2005 group, the incisional hernia rate was 15.3% ($n=13$) and for the 2009 group, it was 3.6% ($n=5$) ($p<0.01$). The body mass index was higher in patients who developed incisional hernias than in those who did not ($p=0.02$).

CONCLUSIONS The 2005 group had a significantly higher incisional hernia rate than the 2009 group. This is due to the differences in the incision technique and extraction site between the two groups.

KEYWORDS

Laparoscopic Surgery – Incisional hernia – Extraction site

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Incisional hernia is one of the most common complications after abdominal surgery. The reported incidence after a midline laparotomy ranges from 3% to 20%.¹ Approximately 50% of incisional hernias are diagnosed within the first year following surgery although they can occur many years later.² This complication can result in patient morbidity and the requirement for additional surgical procedures for hernia repair,³ which can be associated with high recurrence rates.^{4,5}

Risk factors for the development of incisional hernias are a combination of patient related factors, surgical factors and postoperative factors with surgical site infection often being cited as the most important independent risk factor.⁶ It has been suggested that the rate of incisional hernias following laparoscopic colorectal procedures may be reduced owing to the absence of a large abdominal wound.^{7,8} However, long-term data demonstrate that the incisional hernia rate is similar after laparoscopic and open colorectal resections.^{9,10}

Although there have been several reports in the literature looking at the incisional hernia rate after laparoscopic and open colorectal resections, there are relatively few studies investigating the possible association of site of specimen extraction and development of incisional hernias. The aim of this study was therefore to evaluate the effect of different extraction sites on the incisional hernia rate in laparoscopic colorectal resections.

Methods

Patients who underwent laparoscopic colorectal resections were identified retrospectively from a prospectively maintained database at a single centre. Consecutive patients who underwent laparoscopic colorectal resections between 1 January and 31 December 2005 and those who underwent laparoscopic colorectal resections between 1 January and 31 December 2009 were considered for inclusion. All operations were performed by colorectal surgeons. All

patients in the 2005 group had specimens extracted through transverse muscle cutting incisions. After a review of practice in the department, a decision was made to standardise the extraction site for laparoscopic colorectal resections. A midline incision was used for the standardised extraction site. All patients in the 2009 group had specimens extracted through midline incisions made at the umbilicus.

Inclusion criteria consisted of patients over the age of 18 and patients undergoing primary laparoscopic colorectal resection. Patients who were lost to follow-up or had incomplete operative data were excluded. All patients were followed up for at least two years.

Medical records were reviewed for collection of data including demographic information, diagnosis, operation performed, tissue pathology, postoperative complications, medical co-morbidities, ASA (American Society of Anesthesiologists) grade, smoking status and body mass index (BMI). Outpatient clinic notes were reviewed to identify patients who had a diagnosis of an incisional hernia. An incisional hernia was defined as any gap in the abdominal wall, with or without a bulge in the postoperative scar that can be seen or palpated on clinical examination.¹¹ Location, size and subsequent management of the incisional hernia were collected from medical records.

Demographics and risk factors for incisional hernia development were compared between the 2005 and 2009 groups as well as between the incisional hernia and non-incisional hernia groups. Statistical analysis was performed with R statistical software (R Foundation for Statistical Computing, Vienna, Austria) using 1,000,000 permutation samples, Fisher's exact test and binary logistic regression as appropriate. A *p*-value of <0.05 was considered statistically significant.

Results

A total of 277 laparoscopic colorectal resections were identified but 53 patients were excluded: 16 for perineal extraction, 14 for conversion to an open procedure, 9 for death before two years following surgery, 8 for being lost to follow-up and 6 for incomplete notes. As a result, 224 patients (mean age: 67.5 years, standard deviation: 16.35 years) were reviewed, including 113 men (50.4%) and 111 women (49.6%). There were 85 patients in the 2005 transverse group and 139 in the 2009 midline group. In the 2005 group, 11.8% of patients (10/85) were diabetic and in the 2009 group, 2.9% (4/139) were diabetic (*p*=0.01). There were no statistically significant differences in age, sex, patients with ASA grade 3 or 4, smoking status, BMI or deep surgical site infections between the two groups (Table 1).

The overall incisional hernia rate was 8.0% (18/261). The incisional hernia rate for the 2005 transverse group was 15.3% (*n*=13) and for the 2009 group, it was 3.6% (*n*=5) (*p*<0.01). There were no statistically significant differences in age, sex, prevalence of diabetes mellitus, patients with ASA grade 3 or 4, smoking status or deep surgical site infections between the hernia and non-hernia groups. In contrast, BMI was higher in patients who developed incisional hernias than in those who did not (*p*=0.02).

Single predictor binary logistic regression models were used to analyse age, sex, prevalence of diabetes mellitus, patients with ASA grade 3 or 4, smoking status, BMI and deep surgical site infections as predictors of incisional hernias (Table 2). This analysis showed that low BMI (*p*=0.02) and being in the 2009 group (midline incision) (*p*<0.01) were factors that reduced the risk of incisional hernia development. Furthermore, low BMI and being in the 2009 group did not interact and were

Table 1 Patient demographics

	2005 (<i>n</i> =85)	2009 (<i>n</i> =139)	<i>p</i> -value
Mean age at operation (years)	65.4 (SD: 17.10)	68.8 (SD: 15.80)	0.15*
Mean weight (kg)	72.2 (SD: 13.80)	72.7 (SD: 14.50)	0.76*
Mean body mass index (kg/m ²)	25.7 (SD: 4.20)	25.8 (SD: 4.10)	0.83*
Mean operative time (hours)	3.55 (SD: 1.33)	3.19 (SD: 1.64)	0.06*
Male	41 (48.2%)	72 (51.8%)	0.68**
Laparoscopic assisted surgery	31 (36.5%)	37 (26.6%)	0.14**
Incisional hernia	13 (15.3%)	5 (3.6%)	<0.01**
Diabetes	10 (11.8%)	4 (2.9%)	0.01**
Smoker	15 (17.6%)	23 (16.5%)	0.86**
Deep wound infection	1 (1.2%)	2 (1.4%)	1.00**
Malignancy	57 (67.1%)	103 (74.1%)	0.29**
ASA grades 2–4	59 (69.4%)	102 (73.4%)	0.54**

*calculated using 1,000,000 permutation samples
**calculated using Fisher's exact test

Table 2 Risk factors for incisional hernias

	Odds ratio (95% CI)	p-value*
Age at operation (years)	1.02 (0.99–1.05)	0.27
Weight (kg)	1.03 (1.00–1.07)	0.08
Body mass index (kg/m ²)	1.14 (1.02–1.27)	0.02
Operative time (hours)	0.94 (0.68–1.28)	0.67
Cohort (2005)	0.22 (0.07–0.58)	<0.01
Male	0.60 (0.28–1.61)	0.31
Laparoscopic assisted surgery	1.95 (0.73–5.17)	0.18
Diabetes	3.55 (0.89–14.10)	0.07
Smoker	0.27 (0.03–2.08)	0.21
Deep wound infection	6.00 (0.52–69.60)	0.15
Malignancy	0.47 (0.18–1.24)	0.13
ASA grades 2–4	7.32 (0.95–56.19)	0.06

CI = confidence interval; ASA = American Society of Anesthesiologists
*calculated using single predictor binary logistic regression

independent factors for reducing the risk of incisional hernia development.

All available computed tomography (CT) of patients with incisional hernias was reviewed. CT was available for all patients who developed a hernia in the 2009 group but it was only available for eight hernia patients in the 2005 group (Table 3). In the 2005 (transverse incision) group, eight incisional hernia patients underwent operative hernia repairs and of these, only three had CT available to review. In the 2009 (midline incision) group, of the five patients who developed an incisional hernia, two underwent operative hernia repair.

Discussion

A Cochrane review of randomised trials reporting long-term outcomes of laparoscopic and open colorectal resections did not show any difference in incisional hernia rates between the two surgical approaches.¹² Other surgical factors such as extraction site, incision technique, closure method and whether the procedure was hand-assisted or laparoscopic only may have also contributed to these incisional hernia rates. Furthermore, both of the two trials in the Cochrane review that reported incisional hernia rates used a midline incision for laparoscopic as well as for open surgery.^{9,15}

Table 3 Patients with incisional hernias

Patient	Age / sex	Diagnosis	Operation	Year	Time from operation to hernia diagnosis	Width of hernia on CT	EHS classification
1	73 M	Crohn's disease	Right hemicolectomy	2005	43 days	CT not available	–
2	74 M	Adenocarcinoma	Left hemicolectomy	2005	354 days	8.68cm	W2
3	80 F	Adenocarcinoma	Sigmoid colectomy	2005	106 days	3.91cm	W1
4	81 F	Adenocarcinoma	Right hemicolectomy	2005	286 days	3.05cm	W1
5	75 F	Diverticular disease	Sigmoid colectomy	2005	386 days	5.00cm	W2
6	81 F	Adenocarcinoma	Left hemicolectomy	2005	665 days	CT not available	–
7	43 F	Adenocarcinoma	Anterior resection	2005	200 days	3.56cm	W1
8	71 F	Diverticular disease	Sigmoid colectomy	2005	557 days	CT not available	–
9	65 M	Adenocarcinoma	Sigmoid colectomy	2005	288 days	1.40cm	W1
10	83 F	Diverticular disease	Sigmoid colectomy	2005	194 days	CT not available	–
11	79 F	Diverticular disease	Sigmoid colectomy	2005	285 days	CT not available	–
12	76 M	Adenocarcinoma	Right hemicolectomy	2005	581 days	4.49cm	W2
13	64 M	Ulcerative colitis	Proctocolectomy	2005	250 days	12.52cm	W3
14	85 F	Diverticular disease	Sigmoid colectomy	2009	84 days	2.15cm	W1
15	73 M	Adenocarcinoma	Anterior resection	2009	495 days	1.86cm	W1
16	70 F	Adenocarcinoma	Left hemicolectomy	2009	337 days	7.12cm	W2
17	59 M	Adenocarcinoma	Sigmoid colectomy	2009	349 days	5.50cm	W2
18	62 F	Adenocarcinoma	Sigmoid colectomy	2009	462 days	2.71cm	W1

CT = computed tomography; EHS = European Hernia Society

In open abdominal surgery, the effect of type of incision on hernia rates has been described in the literature. Most studies have found that incisional hernia rates are higher with midline incisions than with transverse incisions.^{14,15} The evidence in the literature regarding laparoscopic surgery is more limited, with only a few studies investigating the effect of the type and location of incision used for specimen extraction on incisional hernia development.

A retrospective review of 208 laparoscopic colorectal resections by Singh *et al* found operations that used a paramedian (muscle splitting) incision for the extraction site resulted in a significantly lower incisional hernia rate than operations with midline incisions.¹⁶ They also found that there were no statistically significant differences between the two groups in age, BMI, diabetes or wound infection. DeSouza *et al* performed a retrospective review of 512 patients comparing incisional hernia rates in open colorectal operations using standard midline incisions and hand-assisted laparoscopic colorectal operations that used midline and Pfannenstiel incisions for extraction sites.¹⁷ They reported similar incisional hernia rates for the open and laparoscopic midline groups while no patients in the laparoscopic Pfannenstiel group developed incisional hernias.

A review of 99 laparoscopic colectomies by Lee *et al* reported incisional hernia rates of 29%, 14% and 0% after specimen extraction through midline, transverse and Pfannenstiel incisions respectively.¹⁸ They suggested that transverse incisions, including Pfannenstiel incisions, are based on better anatomical principles since muscle fibres are split along the direction of their fibres, and blood supply to the oblique and transverse muscles are less likely to be disrupted as the incision is parallel to segmental arteries. This theory is supported by a study by Samia *et al*, who also found higher incisional hernia rates with midline incisions.¹⁹ This group emphasised that a muscle splitting technique for the creation of the extraction site was key to reducing the incidence of hernia formation. Additionally, in the analysis of incisional hernia risk factors, they found that higher BMI was associated with increased incisional hernia rates.

Our overall incisional hernia rate of 8.4% is comparable with similar studies.^{15,18} Contrary to the previous studies investigating extraction site and incisional hernia rate, we found that transverse incisions (2005 group) were associated with a higher rate of incisional hernias than midline incisions (2009 group). This may be due to the technique employed to make the incision for the extraction site rather than the location of the extraction site.

Transverse incisions in the 2005 group were made in various sites through the abdominal wall according to the location of the specimen. A muscle cutting technique was used to make these incisions rather than a muscle splitting technique. This technique may have involved dissection of muscle fibres in a direction that was at an oblique angle or even perpendicular to their natural course. This type of incision may have also resulted in disruption of blood vessels supplying the muscle. Wound healing at the extraction site may therefore have been impaired, leading to an increased risk of incisional hernia development. The midline incisions used for specimen extraction in the 2009

group avoided cutting through muscle and this may account for the lower incisional hernia rate. In a small series of right laparoscopic colectomies published by Williams *et al*, incisional hernias were avoided through retraction of the rectus abdominis muscle rather than using muscle cutting incisions for specimen extraction.²⁰

Study limitations

This study was limited by its non-randomised retrospective nature as well as several other factors. A minimum follow-up duration of two years could be considered a limitation. However, the majority of incisional hernias occur in the first two years following surgery and the risk of developing an incisional hernia is 2% a year thereafter.² This increase in risk is inexorable and does not plateau, as shown by long-term studies of hernia recurrence rates after incisional hernia repair.²¹ The additional benefit of following these patients up over a longer time period may therefore be limited. Furthermore, information regarding hernias was restricted to documentation from outpatient visits. Although postoperative CT was available for all the patients in the 2009 group, imaging records were incomplete for many patients in the 2005 group. Consequently, it was not possible to categorise all incisional hernias according to the European Hernia Society incisional abdominal wall hernia classification.¹¹

The exact incision length for the extraction site was not recorded in our prospective database and it was therefore not possible to analyse the relationship between incision length and incisional hernia rate. Incision lengths for extraction sites were 5–6cm unless the size of tumour necessitated a larger incision. Previous trials have reported no difference in incisional hernia rates between open and laparoscopic colorectal resections,^{8,12} thereby demonstrating that wound length may not be a surgical factor that influences incisional hernia rates.

Conclusions

In our series, midline extraction sites for laparoscopic colorectal surgery resulted in a lower incisional hernia rate than transverse muscle cutting extraction sites. Similar studies in the literature have found that transverse muscle splitting extraction sites lead to lower incisional hernia rates than midline incisions. The higher incisional hernia rates with transverse extraction sites in our series may have been due to the muscle cutting technique used rather than the location of the transverse incisions.

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