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Incidence and risk factors for the development of incisional hernia following elective laparoscopic versus open colon resections

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Abstract

BACKGROUND: There are few studies that compare the incidence of incisional hernia following elective laparoscopic colon resection to open colectomy and determine the risk factors for its development.

METHODS: Elective open and laparoscopic colon resections performed between February 2002 and May 2007 were reviewed. In the laparoscopic group, mesenteric transection was performed via intracorporeal division for left-sided colectomy and via extracorporeal technique for right-sided colectomy. The ileocolic anastomosis was performed by extracorporeal stapling for right colectomies and by intracorporeal for left colectomies.

RESULTS: Two hundred eighteen patients (mean age 62 years, 52% male) underwent elective colon resection (50% open, 5% hand-assisted, and 45% laparoscopic). Six percent of the cases that started as laparoscopic were converted and are included in the open group. Mean follow-up was 26 months. The overall incisional hernia rate was 16% (open and minimally invasive group 17% vs 15%, $P = .14$). Hernia was not dependent on the type of resection, indication, or extraction site. Body mass index >36 kg/m^2, male gender, and surgical site infection were risk factors for hernia development.

CONCLUSIONS: Laparoscopic colectomy does not reduce the development of incisional hernia.

The overall incidence of incisional hernia following laparotomy is reported to be between 11% and 23%.[1–3] Contributing risk factors include morbid obesity, smoking, corticosteroid use, pulmonary disease, malnutrition, renal failure, and surgical site infections.[4] Although often times asymptomatic, incisional hernias are the source of great morbidity ranging from poor cosmetic appearance to chronic abdominal pain, bowel incarceration, and need for emergency or elective repair.

Several studies validate the benefits associated with laparoscopic colon resection. Such benefits include the attenuation of postoperative immune suppression, earlier return of bowel function and oral intake, decreased analgesic requirements, faster return to normal activity, shortened length of stay, and improved 30-day morbidity without violating the principles oncological resection.[5–11] However, few studies have addressed the question of whether or not laparoscopic colon resection, with its smaller incisions and limited abdominal wall trauma, provides any protection against the development of incisional hernias. Moreover, the limited

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data available are conflicting, with some authors reporting the incidence of incisional hernia following open and laparoscopic colectomy equal, while others describe a clear benefit to the laparoscopic approach.[12–14]

The purpose of this study is to evaluate the incidence of incisional hernia following elective minimally invasive colon resection, to determine if it is lower than that reported following traditional open colectomy, to identify patient-related risk factors, and to ascertain the influence of alternative extraction sites.

Methods

The medical records of 109 consecutive patients who underwent elective minimally invasive colon resection between February 2002 and August 2007 were reviewed and compared with a contemporaneous cohort of 109 open colectomies. The same surgeons performed both the open and the laparoscopic resections and decided on the approach based on the size of the tumor, underlying medical problems, and prior abdominal and pelvic surgery.

Open colectomies were performed in the standard fashion. All incisions were made along the linea alba (range 11–17 cm) and the extra-large Alexis wound retractor system (Applied Medical, Rancho Santa Margarita, CA) was used in all but the first 13 patients. The skin was then closed with surgical clips. Any case requiring a skin opening larger than 7 cm in length was considered an "open" operation.

In the minimally invasive group the mesentery was divided using the LigaSure device (Valley Lab, Boulder, CO) for left colectomy and divided after exteriorized and secured using absorbable ligatures for right colectomy. The ileocolic anastomosis was performed by extracorporeal stapling for right colectomies and by intracorporeal transanal stapling technique for left colon resections. A 6- to 7-cm incision was made to place the medium Alexis wound retractor, which was used in all cases. The skin incision was made longitudinally in all right-sided cases, most often in the right midclavicular position. The fascial opening was made in the right paramedian location. In left-sided cases, the specimen was extracted via a transverse suprapubic incision, but the fascial opening was made longitudinally along the linea alba.

All abdominal wall closures were performed with #1 polydioxanone (PDS) fascial suture in a continuous running fashion and skin clips. All trocar sites >5 mm were closed in 1 layer using skin clips. A figure of 8 suture of #O PDS was used to close all 10 trocar sites ≥10 mm.

A diagnosis of incisional hernia was made by the presence of a reducible mass along the surgical scar or by oral contrast-enhanced computed tomography scan in patients with symptoms of abdominal wall pain in whom it was not clearly diagnosed by physical examination.

Data were analyzed using Statistical Package for the Social Sciences for Windows 16 (SPSS, Inc, Chicago, IL). Prior to conducting the study, a power analysis was conducted to determine the number of cases necessary to review to identify a statistically reduced incidence of incisional hernia, based on previously published studies. Fisher exact test, analysis of variance, and χ^2 test were used as appropriate. Multivariate analysis was also performed to determine risk factors for the development of incisional hernia. A P value $<.05$ was considered statistically significant.

Results

During the study period 218 patients (52.2% male, 47.7% female) underwent elective colon resection. Their demographics are listed in Table 1. One hundred nine of these patients (54% male, 46% female) underwent minimally invasive colon resection (90% laparoscopic, 10% hand-assisted) with specimen extraction through the abdominal wall. Six additional patients (included in the open colectomy group) required conversion to an incision of ≥11 cm to complete the operation, usually due to the need to obtain better mobilization of the colon to optimize the resection and/or anastomosis.

The mean age of the entire cohort was 62.0 ± 13.87 years (open group 64.3 ± 13.5 years, minimally invasive group 59.6 ± 13.9 years, $P = .020$). Segmental resections included right colectomy (n = 79, 36%), sigmoid colectomy (n = 60, 28%), anterior resection (n = 26, 12%), left colectomy (n = 17, 8%), subtotal colectomy (n = 14, 6%), extended right colectomy (n = 8, 4%), transverse colectomy (n = 6, 3%), abdominoperineal resection (n = 6, 3%), and extended left colectomy (n = 2, 1%).

Open procedures were performed via a midline incision in all but 12 of 109 cases (89% midline, 9% right transverse, 1% pararectus, and 1% left transverse). In the minimally invasive group, extraction sites were 38% periumbilical, 29% left transverse, 26% paramedian, 3% Pfannenstiel, 3% right transverse, and 1% epigastric. Final pathology was 63% neoplasia, 12% diverticulitis, 7% polyps, 6% other, 6% diverticulosis, 5% inflammatory bowel disease, 1% ischemic bowel, and 1% angiodysplasia.

The overall incisional hernia rate was 16% (n = 34). None of the hernias developed at a site other than the colon extraction site. No significant difference was noted in the incidence of incisional hernia between the open and minimally invasive group (open group 17%, minimally invasive group 15%, $P = .14$) (Table 2). As expected, all incisional hernias in the open group occurred at the laparotomy site, while hernias in the minimally invasive group all developed at the extraction site. In descending order, the incisional hernias in the minimally invasive group were periumbilical (n = 8, 50%), paramedian (n = 3, 19%), left transverse (n = 3, 19%), epigastric (n = 1, 6%), and Pfannenstiel (n = 1, 6%). The mean follow-up period was 25.9 months ± 10.1 months.

Table 1 Open versus laparoscopic group: patient demographics and characteristics

Variable	Open 109 (50%) n (%)	Laparoscopic 109 (50%) n (%)	*P* value
Age (mean ± SD)	64.3 ± 13.51	59.6 ± 14	.020
Gender			
Male	55 (51)	59 (54)	.637
Female	53 (49)	50 (46)	
BMI (mean ± SD)	28.4 ± 4.6	28.3 ± 5.4	.821
Cardiac	15 (14)	19 (17)	.473
PVD	6 (6)	1 (1)	.065
Diabetes	17 (16)	13 (12)	.208
Pulmonary			.329
Asthma	1 (1)	4 (4)	
COPD	3 (3)	1 (1)	
Steroids	2 (2)	2 (2)	1.000
Hepatitis B or C	1 (1)	1 (1)	1.000
HIV	4 (4)	4 (4)	1.000
Preoperative albumin	4.1 ± .6	4.2 ± .4	.352
Smoking			.670
Never	75 (73)	63 (58)	
No–quit	18 (18)	26 (24)	
Yes	9 (9)	19 (18)	
Transfusion			
No	101 (94)	108 (99)	.065
Yes	7 (6)	1 (.9)	
Wound infection			.703
No	99 (90)	103 (94.5)	
Superficial SSI	9 (9)	5 (6)	
Deep SSI	1 (1)	1 (1)	
UTI			1.000
No	105 (96)	105 (96)	
Yes	4 (4)	4 (4)	
Follow up period (mo)	27.7 ± 9.5	24.2 ± 10.6	.031
ASA			.088
1	9 (8)	8 (8)	
2	47 (43)	57 (58)	
3	43 (40)	30 (30)	
4	10 (9)	3 (3)	
Surgery			.001
APR	6 (5)	0 (0)	
Extended left	0 (0)	2 (2)	
Extended right	5 (5)	8 (8)	
LAR	20 (18)	6 (6)	
Left colectomy	5 (5)	12 (11)	
Right colectomy	37 (34)	42 (38)	
Sigmoidectomy	22 (20)	38 (35)	
Subtotal	11 (10)	3 (3)	
Transverse	3 (3)	3 (3)	

BMI = body mass index; PVD = peripheral vascular tissue; COPD = chronic obstructive pulmonary disease; HIV = human immunodeficiency virus; SSI = surgical site infection; UTI = urinary tract infection; APR = abdominoperineal resection; LAR = low anterior resection.

With the exception of age (open group 64.3 ± 13.5 years, minimally invasive group 59.6 ± 13.9 years, $P = .020$), no statistically significant difference was noted in the demographics and characteristics of the open and minimally invasive groups. Although the open group was statistically older by comparison, the American Society of Anesthesiologists (ASA) classification was not found to be different

Table 2 Hernia versus no hernia group: patient demographics and characteristics

Variable	Hernia 34 (16%) n (%)	No hernia 184 (84%) n (%)	*P* value
Age (mean ± SD)	64.2 ± 13.3	61.6 ± 13.9	.312
Gender			.020
Male	24 (71)	90 (51)	
Female	10 (29)	94 (49)	
BMI (mean ± SD)	30.7 ± 6.0	27.9 ± 4.7	.003
Cardiac	4 (12)	30 (16)	.674
PVD	3 (9)	4 (2)	.078
Diabetes	7 (21)	23 (13)	.208
Pulmonary			.195
Asthma	2 (6)	3 (2)	
COPD	1 (3)	3 (2)	
Steroids	1 (3)	3 (2)	.495
Hepatitis B or C	0 (0)	2 (1)	1.000
HIV	0 (0)	4 (2)	1.000
Preoperative albumin	4.0 ± .4	4.1 ± .4	.288
Smoking			
Never	7 (46)	56 (60)	.670
No–quit	4 (27)	22 (24)	
Yes	4 (27)	15 (16)	
Transfusion			
No	32 (94)	178 (97)	.362
Yes	2 (6)	6 (3)	
Wound infection			
No	28 (82)	174 (95)	.027
Superficial SSI	6 (18)	8 (4)	
Deep SSI	0 (0)	2 (1)	
UTI			
No	31 (91)	179 (97)	.112
Yes	3 (9)	5 (3)	
ASA			
1	0 (0)	17 (9)	.034
2	23 (67)	81 (46)	
3	8 (24)	65 (38)	
4	3 (9)	10 (6)	
Approach			.951
Laparoscopic	15 (44)	83 (45)	
Hand assist	1 (3)	11 (6)	
Open	18 (53)	90 (49)	
Surgery			
APR	1 (3)	5 (3)	.097
Extended left	0 (0)	2 (1)	
Extended right	1 (3)	7 (4)	
LAR	1 (3)	25 (14)	
Left colectomy	3 (9)	14 (8)	
Right colectomy	15 (43)	64 (36)	
Sigmoidectomy	6 (18)	54 (29)	
Subtotal	3 (9)	11 (6)	
Transverse	4 (12)	2 (1)	
Extraction site			
Midline (open)	17 (50)	80 (44)	.350
Left transverse	3 (8)	30 (16)	
Epigastric	1 (3)	0 (0)	
Periumbilical	8 (24)	36 (20)	
Paramedian	3 (9)	25 (14)	
Pfannenstiel	1 (3)	2 (1)	
Right transverse	1 (3)	11 (6)	
Midline (all)	26 (76)	116 (63)	.171
Off-midline	8 (24)	68 (37)	

(Continued on next page)

Table 2 *(continued)*

Variable	Hernia 34 (16%) n (%)	No hernia 184 (84%) n (%)	*P* value
Pathology			
Angiodysplasia	0 (0)	1 (1)	.827
Diverticulitis	3 (9)	22 (12)	
Diverticulosis	1 (3)	12 (6)	
IBD	2 (6)	9 (5)	
Neoplasia	23 (67)	115 (63)	
Polyps	4 (12)	12 (6)	
Other	1 (3)	13 (7)	

IBD = inflammatory bowel disease.

between the two ($P = .088$). Patients in the minimally invasive group were more likely to have undergone surgery for benign pathology as reflected by differences in type of resection performed ($P = .001$) and final pathology ($P = .001$). In patients with colorectal cancer, those who underwent open resection were more likely to have an advanced tumor stage ($P = .001$), although no difference was noted for the presence of nodal ($P = .856$) or metastatic ($P = .777$) disease.

When comparing the hernia group (n = 34, 16%) to the nonhernia group (n = 184, 84%), no statistically significant difference was noted with regards to the presence of cardiac disease ($P = .674$), peripheral vascular disease ($P = .078$), diabetes ($P = .208$), pulmonary disease ($P = .195$), corticosteroid use ($P = .495$), hepatitis B or C ($P = 1$), human immune deficiency virus ($P = 1$), preoperative albumin ($P = .288$), prior or current smoking history (.670), urinary tract infection ($P = .102$), or transfusion requirement ($P = .362$). In contrast to that noted in the analysis of the open versus minimally invasive data, patients in the hernia group were more likely to be male (70% vs 51%), have a higher body mass index (30.7 kg/m^2 vs 27.9 kg/m^2), and have a documented surgical site infection (17% vs 10%) in univariate and multivariate analysis. Furthermore, although the ASA classification did differ between the hernia and nonhernia group ($P = .034$) favoring a higher proportion of ASA 1 and 3 in the nonhernia group and ASA 2 and 4 in the hernia group, no difference was noted with regards to type of resection ($P = .097$), final pathology ($P = .827$), or tumor stage ($P = .322$). Incisional hernia development was not found to be dependent on whether the segmental resection was performed by an open or minimally invasive approach ($P = .951$), nor whether a midline versus off-midline incision was used at the time of laparotomy or specimen extraction ($P = .171$).

Comments

Although laparoscopic colon resection has proven to be in many ways superior to open resection, whether or not its limited incisions confer protection against the development of incisional hernia is a topic of debate. Singh et al, in a prospective study of 208 patients who underwent laparoscopic colon resection, found the overall incidence of incisional hernia to be 8%, a number below that reported for open resection.[12] Additionally, it was noted that all incisional hernias occurred at midline extraction sites (midline = 18% vs off-midline 0%, $P = .0002$).[12] Similarly, Andersen et al in a survey with selective examination of 201 patients who had undergone open (n = 143) and laparoscopic (n = 58) sigmoid resection, found a significantly lower incisional hernia rate in those who underwent laparoscopic versus open colon resection (3% vs 15%, $P = .026$).[13] In contrast, Ihedioha et al found no significant difference in hernia rates between those who underwent open (n = 63) and laparoscopic (n = 32) colon resection (9% vs 16%, $P = .52$).[14] Of the 3 hernias identified in the laparoscopic group, 1 occurred at a port site, while the other 2 developed at off-midline extraction sites.[14]

The incisional hernia rate following minimally invasive colectomy in the present study was not statistically different from that of the open colectomy group (15% vs 17%, $P = .139$) and the incisional hernia rate of the open colectomy group is similar to that reported in other series.[1–3] All incisional hernias in the minimally invasive group were noted to occur at extraction sites. Open colectomy cases included, there was no predilection for midline or off-midline incisional hernias (midline = 26, off-midline 8, $P = .171$). This held true in a subgroup analysis of the minimally invasive group extraction sites (midline = 9, off-midline 7, $P = .270$, not included in Table 2). This leads neither to the conclusion that no extraction site is protected, nor disproportionally at higher risk from the development of incisional hernia. Specimen extraction sites should therefore be selected either to facilitate the safe completion of the procedure or, when appropriate, to provide improved cosmetic results (ie, Pfannenstiel incision in a young female patient).

While the extent of resection was not found to be a determinant of incisional hernia development ($P = .097$), of interest 4 of the 6 patients with transverse colectomies (1 open, 3 minimally invasive) included in the series developed incisional hernias ($P = .005$), each at different extraction sites. On further review, all 4 patients were male, each had a body mass index >36 kg/m^2, and all had documented surgical site infections; we found all 3 of these patient-related risk factors to be independently associated with incisional hernia development.

Because most incisional hernias tend to present within the first 2 postoperative years, we feel confident that the overall follow-up period is sufficient to establish an incisional hernia rate in both groups, despite the differences in follow-up between the open and the minimally invasive group (minimally invasive group 24.2 ± 10.6 months, open group 27.7 ± 9.5 months, $P = .032$).[15]

Based on these findings, we believe that the fundamental mechanism associated with fascial failure following colectomy, whether it be an underlying wound healing defect or

wound contamination, is not ameliorated by a minimally invasive approach and therefore the incidence of incisional hernia following laparoscopic colon resection should be similar to that for open resection. Furthermore, obesity, wound infection, and male gender should be considered strong risk factors for incisional hernia development. Specimen extraction site during minimally invasive colon resection should be tailored to facilitate the extraction of the specimen, creation of an anastomosis, or for cosmetic appearance with an understanding that no site is protective against incisional hernia formation.

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