ORIGINAL ARTICLE

Advantages of Laparoscopic Colectomy in Older Patients

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Hypothesis: Few data describe the relative benefits of an expedited recovery program and laparoscopic technique in older vs younger patients undergoing colectomy. We compared short-term outcomes in age-matched cohorts of patients undergoing laparoscopic vs open segmental colectomy managed with the Controlled Rehabilitation With Early Ambulation and Diet program.

Design: Four age-matched cohorts of patients were compared: (1) patients 70 years or older undergoing laparoscopic colectomy (group 1), (2) those 70 or older undergoing open colectomy (group 2), (3) those younger than 60 undergoing laparoscopic colectomy (group 3), and (4) those younger than 60 undergoing open colectomy (group 4).

Methods: Data collected included age, sex, body mass index, Physiologic and Operative Severity Score for the Enumeration of Morbidity and Mortality, American Society of Anesthesiologists' score, estimated blood loss, operative duration in minutes, pathologic findings, type of segmental colectomy, complications, mortality, length of hospital stay, and 30-day readmission rate.

Results: Four hundred seventy-six patients fulfilled the inclusion criteria and had complete data available for collection (group 1, 50 patients; group 2, 123 patients; group 3, 181 patients; and group 4, 122 patients). Demographic data, operative procedures, and pathologic findings were similar among the cohorts. The mean ± SEM length of hospital stay was significantly shorter with laparoscopic surgery in both age cohorts (group 1, 4.2 ± 3.0 days; group 2, 9.3 ± 7.6 days; group 3, 3.9 ± 5.9 days; and group 4, 6.1 ± 3.0 days). The mean ± SEM direct hospital costs were significantly lower only with laparoscopic colectomy in the older cohorts. Using the Physiologic and Operative Severity Score for the Enumeration of Morbidity and Mortality, it was noted that group 2 experienced an observed rate of morbidity similar to that predicted. Conversely, groups 1, 3, and 4 had rates that were significantly lower than expected. Mean ± SEM readmission rates were comparable in the older cohorts (group 1, 6.0%, and group 2, 6.5%) but significantly different in the younger cohorts (group 3, 9.4%, and group 4, 4.1%).

Conclusions: The Controlled Rehabilitation With Early Ambulation and Diet program in combination with laparoscopic segmental colectomy can be safely performed in all age groups. The technique offers particular advantages to older patients because of reductions in length of hospital stay, morbidity and mortality rates, and direct cost of care.

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THE CLINICAL BENEFITS of accelerated recovery after colorectal surgery have been increasingly appreciated during the last 5 years.[1-11] Changes in perioperative care plans and laparoscopic techniques have aimed at reducing perioperative stress, decreasing morbidity and mortality, and lowering the overall resource consumption for patients of all ages.[1-14] The major emphasis of these programs is to encourage earlier resumption of oral intake to reduce ileus and to provide adequate analgesia so that ambulation can be expedited.

Most evidence suggests that laparoscopic colectomy can be performed safely for several pathologic conditions.[12-14] The resulting advantages of smaller wounds, shorter ileus, earlier resumption of dietary intake, and reductions in length of hospital stay are associated with this approach.[12-15] Bardram and colleagues[16] applied a rapid rehabilitation program to a small cohort of older (median age, 81 years) patients and demonstrated a median length of hospital stay of 2.5 days, despite a 22% rate of conversion to an open procedure.

To our knowledge, there are no substantial data that compare the relative risks and benefits of operative intervention and expedited recovery programs in patients undergoing open vs laparoscopic colectomy or, in particular, that assess whether

equivalent benefits are obtained by older and younger patients. The objective of this study was to compare short-term outcomes in 4 cohorts of patients managed with a rapid postoperative recovery program: (1) patients 70 years or older undergoing laparoscopic colectomy (group 1), (2) those 70 or older undergoing open colectomy (group 2), (3) those younger than 60 undergoing laparoscopic colectomy (group 3), and (4) those younger than 60 undergoing open colectomy (group 4).

METHODS

Data on all patients undergoing elective segmental colectomy for any pathologic condition without prior major abdominal surgery between March 1, 1999, and December 31, 2001, were evaluated. All open surgery cases were evaluated for exclusion criteria that would have precluded a laparoscopic approach by us: body mass index greater than 36 (calculated as weight in kilograms divided by the square of height in meters) and prior major laparotomy, excluding cholecystectomy, abdominal hysterectomy, and appendectomy. The 4 cohorts of patients already described were compared.

The perioperative care plan used for these patients, Controlled Rehabilitation With Early Ambulation and Diet (CREAD), has been separately evaluated in patients undergoing laparoscopic and open colectomy.[15,17] None of the patients accepted in the present study were specifically included in either of those studies. Before surgery, the patient was instructed regarding the components of the care plan and was provided an information sheet highlighting the expected milestones. Based on patient preference, an intravenous patient-controlled anesthesia system or patient-controlled epidural anesthesia consisting of fentanyl citrate and bupivacaine hydrochloride regimen was used. Analgesia was supplemented with 30 mg intravenous ketorolac tromethamine every 6 hours, if needed. Orogastric tubes were placed after induction of anesthesia and removed before endotracheal extubation. Ambulation was encouraged the evening of surgery and at least 5 times per day starting on the first postoperative day. The first meal offered was clear liquids as soon as the patient was free of nausea and had recovered from the anesthetic. Patients were allowed to advance to a general diet as tolerated. Oral analgesia was started once the patient tolerated solids, generally on the first postoperative day for patients who underwent laparoscopic colectomy and on the second day for those who underwent open colectomy. The catheter was removed from the bladder on day 1 or 2, depending on the need for epidural analgesia. Before discharge, all patients passed flatus or stool, tolerated at least 3 solid meals, and had adequate oral analgesia.

Data collected included age, sex, Physiologic and Operative Severity Score for the Enumeration of Morbidity and Mortality (POSSUM), American Society of Anesthesiologists' score, estimated blood loss, operative duration in minutes (defined as time from incision to wound closure), pathologic findings, type of segmental colectomy, complications, mortality, length of hospital stay, and 30-day readmission rate. The POSSUM is a validated scoring system used to predict outcome after colon resection.[18] The system uses 12 physiologic variables and 6 operative variables to predict expected mortality and morbidity. Direct cost per case was assessed using data provided by Stanford University's (Palo Alto, Calif) integrated hospital cost management and decision software (Transition Systems, Inc, Boston, Mass). This software provided direct cost per case for charges associated with laboratory services, the pharmacy, radiology, anesthesia, the operating room, and hospitalization. Acquisition costs were applied for disposable operative equipment. There was no attempt to address total cost per case, as indirect fixed and variable indirect costs were not included. Data on professional charges were not included in the study.

Table 1. Demographic Characteristics for the 4 Patient Cohorts*

Demographic	Group 1 (n = 50)	Group 2 (n = 123)	Group 3 (n = 181)	Group 4 (n = 122)
Age, y	77.5 ± 4.6	77.8 ± 5.4	42.4 ± 12.3	46.7 ± 9.8
M/F	28/22	67/56	94/87	68/54
OR, min	102 ± 41	160.2 ± 53†	110 ± 53	155 ± 45†
Blood loss, mL	121 ± 100	293 ± 311†	121 ± 141	260 ± 258†
LOS, d	4.2 ± 3.0	9.3 ± 7.6†‡	3.9 ± 5.9	6.1 ± 3.0†
ASA score (1/2/3/4)	0/8/34/8	0/17/89/17	14/145/22/0	8/74/40/0
Direct cost per case, $	3920 ± 1949	6448 ± 8130‡	3616 ± 2990	3804 ± 1773

Abbreviations: ASA, American Society of Anesthesiologists; LOS, length of stay; OR, operative time.
*Data are given as mean ± SEM unless otherwise indicated.
†$P<.05$, group 1 vs group 2; group 3 vs group 4, analysis of variance.
‡$P<.05$, group 2 vs all groups, analysis of variance.

Data are presented as mean ± SEM for parametric data and median (interquartile range) for nonparametric data. Statistical analysis consisted of the Wilcoxon rank sum test, χ^2 test, and analysis of variance as appropriate, with significance set at $P<.05$. The study was performed using data from institutional review board–approved databases. All laparoscopic conversions to open procedures were included in the respective laparoscopic groups, based on intention to treat.

RESULTS

Four hundred seventy-six patients fulfilled the inclusion criteria and had complete data available for collection. The numbers in each cohort were as follows: group 1, 50 patients; group 2, 123 patients; group 3, 181 patients; and group 4, 122 patients. Based on the research design, there was a significant difference in mean age between the cohorts; however, there was no significant age difference between groups 1 and 2 or between groups 3 and 4 (**Table 1**). Other demographic data are given in Table 1. The distribution of operative procedures among the cohorts is given in **Table 2**.

The length of hospital stay was significantly shorter in the laparoscopic groups (Table 1). Among patients who underwent open surgery, group 2 had a significantly longer hospital stay compared with that of group 4.

In the older groups, those who underwent laparoscopic surgery incurred significantly lower direct hospital costs. Total direct costs were similar for the 2 operative approaches in the younger cohorts, indicating that a laparoscopic approach is not necessarily associated with high costs. The direct costs were similar between the 2 laparoscopic cohorts, whereas costs in group 2 were significantly higher than those in group 4 (Table 1).

The specific morbidities experienced by the groups are given in **Table 3** and **Table 4**. Using the POSSUM, the only group that had an observed rate of morbidity similar to that predicted was group 2. This rate was significantly higher than those in the other 3 cohorts, who

Table 2. Distribution of Operative Procedures and Pathologic Findings Among the Patient Cohorts

Procedure	Group 1 (n = 50)	Group 2 (n = 123)	Group 3 (n = 181)	Group 4 (n = 122)
Right colectomy				
Adenoma	8	14	4	3
Cancer	9	74	22	37
Angiodysplasia	2	2	0	
Other	1 Diverticulitis	1 Volvulus, 2 iatrogenic injury	0	1 Volvulus, 1 perforated appendix
Total	**20**	**93**	**26**	**42**
Ileocolectomy				
Crohn disease	0	0	40	10
Other	0	1 Perforated appendix	0	0
Total	**0**	**1**	**40**	**10**
Sigmoidectomy				
Diverticulitis	13	11	79	34
Adenoma	4	0	2	0
Cancer	8	16	18	25
Other	0	0	2 Crohn disease	2 Crohn disease
Total	**25**	**27**	**101**	**61**
Rectopexy	5	2	14	9

Table 3. Distribution of All Complications Among the Patient Cohorts*

Complication	Group 1 (n = 50)	Group 2 (n = 123)	Group 3 (n = 181)	Group 4 (n = 122)
Prolonged ileus (4 days)	0	15 (12)†	2 (1.1)	7 (5.7)†
Small-bowel obstruction				
Nonoperative intervention	0	1 (0.8)	2 (1.1)	3 (2.5)
Operative management	0	1 (0.8)	3 (1.7)	0
Cardiac complications	2 (4.0) (1 Atrial tachycardia, 1 congestive heart failure)	5 (4.1) (3 Myocardial infarction, 2 congestive heart failure)	1 (0.6) (Atrial tachycardia)	1 (0.8) (Atrial tachycardia)
Chest complications	0	8 (6.5)	1 (0.6)	2 (1.6)
Wound infection	1 (2.0)	5 (4.1)	2 (1.1)	1 (0.8)
Anastomotic leakage or abdominal abscess	0	4 (3.3)	5 (2.8)	1 (0.8)
Generalized peritonitis and septicemia	0	2 (1.6)	0	0
Other	5 (10.0)	5 (4.1)	3 (1.7)	1 (0.8)
Total	**8** (16.0)	**46** (37.4)†	**19** (10.5)	**16** (13.1)

*Data are given as number (percentage).
†$P<.05$.

Table 4. Reasons for Readmission Within 30 Days of Discharge*

Reason	Group 1 (n = 50)	Group 2 (n = 123)	Group 3 (n = 181)	Group 4 (n = 122)
Small-bowel obstruction	1	3	7	2
Leakage	0	1	0	1
Cardiac complications	0	1	0	0
Wound complications	0	1	0	0
Intra-abdominal collection	0	0	4	1
Other	2	2	6	1
Total	**3** (6.0)	**8** (6.5)	**17** (9.4)†	**5** (4.1)

*Data are given as number and number (percentage).
†$P<.05$.

Table 5. Ratios of POSSUM Observed to Expected Morbidity and Mortality for the 4 Patient Cohorts

Ratio	Group 1 (n = 50)	Group 2 (n = 123)	Group 3 (n = 181)	Group 4 (n = 122)
Mortality (observed-expected)	0:7.9*	1.6:5.2*	0:2.3	0:2.7
Morbidity (observed-expected)	5.9:29.9*	25.2:27.2	5.9:12.3*	6.6:14.2*

Abbreviation: POSSUM, Physiologic and Operative Severity Score for the Enumeration of Morbidity and Mortality.
*$P<.05$, χ^2 test.

experienced similar complication rates that were significantly lower than predicted rates (**Table 5**). Among all patient cohorts, the mortality rates were significantly lower than predicted, as there were only 2 mortalities, both occurring in group 2 (Table 5).

Readmission rates within 30 days were comparable in the older groups (group 1, 6.0%, and group 2, 6.5%). In the younger cohorts, those who underwent laparoscopic surgery had a significantly higher readmission rate (group 3, 9.4%, and group 4, 4.1%). There were no significant differences in the reoperation rates among the cohorts (group 1, 0%; group 2, 0.8%; group 3, 1.6%; and group 4, 0%).

COMMENT

In the not-so-distant past, advanced age was considered a contraindication for major colectomy because of the significant risk of postoperative morbidity and mortality.[18] Operative morbidity and mortality in older patients is closely tied to the number and severity of comorbid illnesses.[19-23] Greenburg et al[24] reported an operative mortality of 4% in a group of patients undergoing open colectomy who preoperatively had normal chest x-ray films, renal function, and white blood cell counts and an absence of cardiomegaly. The presence of at least 2 significant comorbidities has a substantial effect in patients older than 70 years, with Boyd et al[25] describing a mortality of 16.2% in an older cohort compared with 8.6% in a younger one.

Several authors have evaluated the outcomes of patients undergoing laparoscopic colectomy. Stewart et al[26] recently reported results of a cohort study of patients older than 80 years undergoing open or laparoscopic colectomy; they identified a 41% reduction in the length of hospital stay and a greater percentage of patients achieving normal activity within 1 month after surgery in the laparoscopic group. Reissman et al[27] compared a group of older patients with a high incidence of comorbid illnesses with a younger patient cohort and found similar lengths of hospital stay and postoperative morbidity in the 2 age groups undergoing colorectal surgery. Bardram et al[16] used a rapid rehabilitation program of epidural anesthesia, early feeding, and aggressive ambulation and achieved a median length of hospital stay of 2.5 days in older patients who underwent laparoscopic colonic resection. Delgado et al[28] presented data from a prospective colon cancer trial that demonstrated a higher morbidity in patients older than 70 years who underwent open surgery vs patients of similar age who underwent laparoscopic procedures. In addition to shorter hospital stays and lower morbidity rates, laparoscopic colectomy may allow for a more frequent and earlier return to independent living.[28,29] Schwandner et al,[30] however, found a longer operative duration, greater consumption of intensive care resources, and an overall longer hospital stay in patients older than 70 undergoing laparoscopic colectomy compared with those younger than 70. This was a German study, and cultural influences and practice patterns may have affected the outcomes.

In typical series,[1-4] the postoperative length of hospital stay after major gastrointestinal surgery is between 5 and 10 days. Longer length of hospital stay in older patients may be the result of postoperative pain, slow return of gastrointestinal function, physical deconditioning and fatigue, or postoperative complications.[3] Kehlet and Mogensen[3,4] attempted to address these issues by evaluating the benefits of a rapid rehabilitation program and described a median postoperative stay of 2 days after elective open sigmoid colectomy. His group found similar results in a group of patients older than 80 years using the program following laparoscopic colonic resection.[16]

Several multimodal care plans that successfully reduce the length of hospital stay for colorectal surgery have been advocated, although most exclude the use of epidural analgesia, oral cathartics, and prokinetic agents.[7-11] Unfortunately, a common sequela of these programs is substantial readmission, despite differences in discharge criteria (eg, tolerating a clear liquid diet with or without evidence of gastrointestinal function).[9,11] With the CREAD program, significant reductions in length of hospital stay were obtained for patients undergoing open and laparoscopic colectomies.[15,17]

Our data demonstrate that laparoscopic colectomy in combination with the CREAD program safely reduced the length of hospital stay by 54.9% in older patients and by 36.1% in younger patients. There was an associated significant reduction in the direct cost of caring for patients in group 1 ($3920) vs group 2 ($6448). In addition, laparoscopic colectomy reduced the postoperative morbidity in group 1 well below the POSSUM predicted rates and significantly lower than that of group 2. Two surrogates for operative stress, operative duration and estimated blood loss, were also significantly reduced in both laparoscopic groups.

The limitation of this study is the use of cohort methods. We attempted to reduce bias by including all index cases performed by open and laparoscopic techniques. To minimize selection bias in the laparoscopic group, we also did not include open surgery cases that represented significant reoperative abdominal surgery, as only 2 surgeons performed laparoscopic procedures. The American Society of Anesthesiologists' score and POSSUM were used in an attempt to assess the risk of the patient groups. As expected, the 2 older cohorts of patients appeared to be at greater risk, as demonstrated by a higher percentage of patients with an American Society of Anesthesiologists' score of 3 or 4 and a higher predicted morbidity and mortality rate by POSSUM.[30-34]

CONCLUSIONS

Our data demonstrate that a combination of the CREAD program and laparoscopic segmental colectomy can be safely performed in all age groups. The laparoscopic technique is particularly advantageous for older patients, as it reduces the length of hospital stay, morbidity and mortality rates, and direct cost of care compared with those associated with open colectomy.

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