

Laparoscopic Resection for Colon Cancer: Would all Patients Benefit?

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PURPOSE: This study was designed to assess whether the exclusion criteria used in the Clinical Outcomes of Surgical Therapy and Colon Cancer Laparoscopic or Open Resection trials affected the generalizability of their findings.

METHODS: A prospective database of consecutive laparoscopic resections performed for colon cancer was reviewed. Patients were categorized into two groups: inclusion group and exclusion group, based on the selection criteria used in the Clinical Outcomes of Surgical Therapy and Colon Cancer Laparoscopic or Open Resection trials. Baseline and perioperative data were analyzed by using *t*-tests, Wilcoxon's rank-sum, chi-squared, and Fisher's exact test. Kaplan-Meier survival curves, followed by adjustment for tumor nodes metastasis stage and age utilizing a Cox proportional hazard model, were performed.

RESULTS: The inclusion group had 221 patients and the exclusion group had 166 (median age and gender distribution were similar). The exclusion group had a higher conversion rate (23 vs. 11.3 percent; $P=0.0023$). There was no difference in intraoperative complications (9 percent for exclusion group vs. 8.6 percent for inclusion group; $P=0.8$), operative time (180 minutes for exclusion group vs. 172 minutes for inclusion group; $P=0.24$), or postoperative complication rates (33.7 percent for exclusion group vs. 26 percent for inclusion group; $P=0.13$). No difference was detected in perioperative mortality rates, length of stay, days to diet as tolerated, and adjusted two-year survival.

CONCLUSIONS: No differences were found in outcomes between the two groups in terms of operative/postoperative complications, length of stay, perioperative mortality, and two-year survival. It seems that all patients with colon cancer can potentially benefit from a laparoscopic approach.

KEY WORDS: Laparoscopy; Colon; Colorectal.

Laparoscopic colon resections have been performed since the early 1990s.^{1–6} Initial studies examined the adequacy of resection and port site recurrence.^{7,8} Although these issues were addressed,^{9–13} trepidation continued to exist regarding this approach without data related to long-term survival. The publication of well-designed, prospective, randomized trials, such as the Clinical Outcomes of Surgical Therapy (COST)¹⁴ trial, paved the way for widespread agreement that minimally invasive colonic surgery is oncologically safe because a five-year survival equivalence was demonstrated between the laparoscopic and open approach.^{14–16}

Randomized, controlled trials by their nature require careful consideration of design methods to ensure scientific rigor. As such, exclusion criteria are created to optimize internal validity. Unfortunately, the exclusion criteria can have negative implications for the generalizability (or “external validity”) of results to real-world practice settings. As a result, surgeons may be reluctant to use an intervention if the patients who they typically treat differ from the subset of patients who met predefined criteria in research that supported the intervention's efficacy. Such concerns were a key reason for assessing the health outcomes of patients who did not meet the inclusion criteria used in COST and Colon Cancer Laparoscopic or Open Resection (COLOR) trials. This study was designed to assess whether laparoscopic resection can be safely performed in patients with colon cancer who were excluded as part of the large, prospective, multicenter COLOR and COST trials.

PATIENTS AND METHODS

A prospective database of consecutive laparoscopic resections performed by four surgeons for colon cancer between April 1991 and May 2005 was reviewed. All patients referred to the surgeons involved after the first two years of the inception of the database were approached laparoscopically (there is no cohort of “open” patients). Patients were categorized into two groups: inclusion group (IG) and exclusion group (EG), based on selection criteria used in the COST and COLOR trials. The EG consisted of patients with body mass index (BMI) > 30, cancers of the transverse colon and splenic flexure, Stage IV patients, acute intestinal obstruction, previous colon resection, previous or concurrent malignancy (except for basal cell cancer and carcinoma

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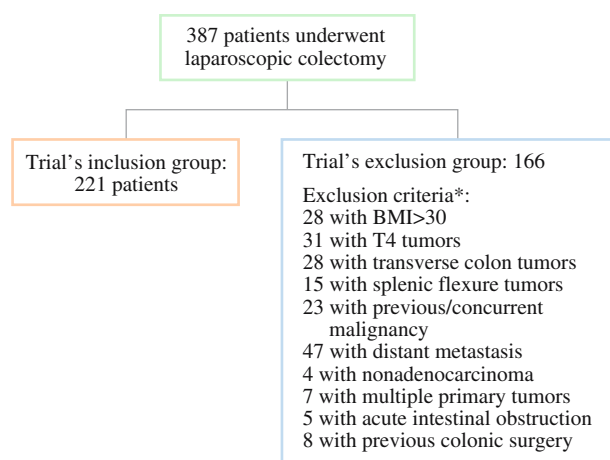


FIGURE 1. Allocation of Patients. *Please note that an individual patient could be allocated to multiple categories for exclusion reason. BMI = body mass index.

in situ of the cervix), and patients with nonadenocarcinoma malignancies. The IG included patients diagnosed with adenocarcinoma in the cecum or ascending/descending/sigmoid colon. It should be noted that this study was designed to examine outcomes in colon cancer, therefore, outcomes in patients with rectal cancer were not considered.

In examining the outcomes, there were several comparisons that were important to perform and were determined *a priori* of reviewing the database. An initial baseline comparison of demographics related to age, gender, and comorbidities to ensure the groups were similar. The operative period (time, complications, conversion rate), postoperative period (complications, length of stay, days to DAT), and long-term outcomes (2-year and 5-year survival) were to be examined. Conversion in this study was defined as conversion to an open approach (it should be noted that the hand-assist device was not used in any of the cases).

Statistical Analysis

Demographic characteristics of patients were described by calculating measures of central tendency and dispersion for relevant risk factors in both groups. Baseline data, intraoperative, and perioperative outcomes between IG and EG were compared. Categorical variables were compared by using chi-squared or Fisher's exact test, whereas *t*-tests or the Wilcoxon's rank-sum test were used for continuous variables. Logistic regression was used to examine the effect of "surgeon" on conversion rate, intraoperative, and postoperative complications.

The most recent information available in the database was used to estimate the distribution of overall survival in both groups. Kaplan-Meier survival curves were constructed to compare two-year and five-year survival between the two groups, and the log-rank test was used to determine whether there was a significant difference. Adjustment for TNM

stage and age was performed by using the Cox proportional hazard model.

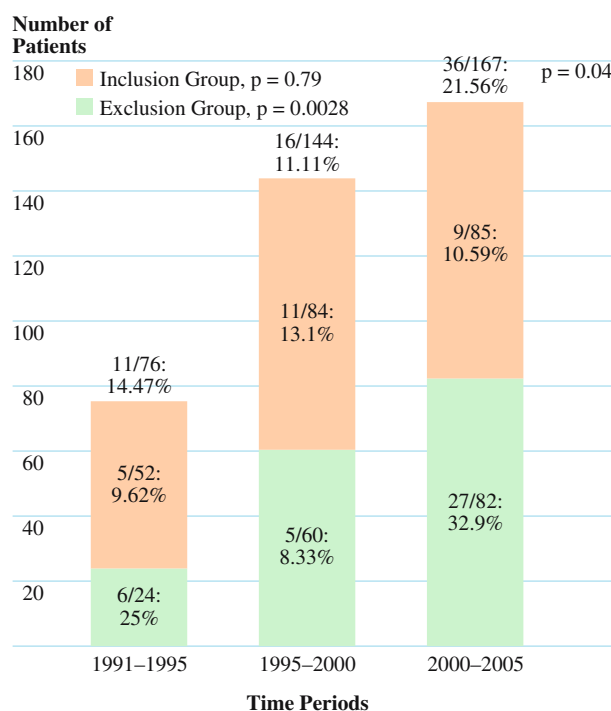
The exclusion group was divided into subgroups based on reason for exclusion. Intraoperative and postoperative outcomes of subgroups with a minimum of 15 patients were compared to the inclusion group by using the statistical methods described above. Results, in subgroups with fewer than 15 patients, are shown without conducting any formal statistical comparison. $P < 0.05$ was considered significant. No adjustments were made for multiple testing.

RESULTS

A total of 387 patients underwent laparoscopic colon resections for cancer; of these 221 (57 percent) patients were allocated to the inclusion group and 166 (43 percent) to the exclusion group. The reasons for placement in the exclusion group are shown in Figure 1.

To examine whether a trend exists in the distribution of IG vs. EG cases over time, the 14-year period of the database was subdivided into three equal intervals (Fig. 2). The proportion of individuals in EG increased from 31.6 percent cases (April 1991–September 1995) to 41.7 percent (October 1995–June 2000) to 49.1 percent (July 2000–May 2005). Furthermore, when the first two years of the database were

FIGURE 2. The conversion rate at the top of each box is the overall conversion rate during that time period. The conversion rate in each box is the conversion rate for the specific group (Inclusion or Exclusion group). The *p* values refer to whether a significant difference exists in the frequency of conversion in the three time periods.



reviewed, 11 of 24 patients (46 percent) were placed into the exclusion group. The conversion rate during this period decreased from the first to second time period and then increased during the last time period.

Patient Demographics

Age and gender distribution were similar between the EG and IG (Table 1). In addition, there was no difference between groups with respect to cardiac or pulmonary comorbidities. Patients in the EG had significantly more previous abdominal surgeries (24 vs. 12 percent; $P=0.0035$). Within the subgroups of the EG, patients with BMI > 30 had a higher rate of previous abdominal surgery compared with the IG (32 vs. 12 percent; $P=0.0093$), and patients with previous/concurrent malignancy were older compared with the IG (74.5 vs. 67 years; $P=0.04$).

There were patients who had more than one reason for being placed in the exclusion group. However, when the exclusion subgroups were analyzed, there was no dif-

ference found in the proportion of patients within each subgroup having multiple reasons for being categorized into the EG ($P=0.26$).

Intraoperative Outcomes

Duration of surgery was similar between the two groups (170 minutes for EG vs. 160 minutes for IG; $P=0.24$). The only subgroup that had a significantly longer operating time was the transverse colon cancer group (205 minutes for EG vs. 160 minutes for IG; $P=0.017$; Table 2).

No difference was found in intraoperative complication rate (9 percent for EG vs. 8.6 percent for IG; $P=0.88$). Assessment for the effect of surgeon did not change this result. There were 19 intraoperative complications in the IG (hemorrhage: 8, perforation: 5, instrument failure (*i.e.*, stapler misfiring): 2, ureteric injury: 3, other: 6) and 15 intraoperative complications in the EG group (hemorrhage: 5, perforation: 3, instrumental failure: 1, other: 6). During analysis of the EG subgroups, patients with

Table 1. Patient demographics

	Mean age (yr)	Gender	Cardiac	Pulmonary	Previous abdominal surgery		
	Median (Q1, Q3)	Female	History	History	None	1	>1
Inclusion group (n=221)	66.68±13.27 67 (58.5, 76)	105 (47)	63 (28.51)	27 (12.22)	194 (88)	22 (10)	5 (2)
Exclusion group (n=166)	68.07±13.76 70 (59, 79) $P=0.15$	85 (52)	51 (30.72) $P=0.63$	28 (16.78) $P=0.19$	127 (76)	31 (19)	8 (5)
BMI > 30 (n=28)	68.1±10.29 67 (63, 73) $P=0.58$	16 (57.14)	17 (60.71) $P=0.0006$	8 (28.57) $P=0.019$	19 (68)	4 (14)	5 (18)
T4 (n=31)	66.67±15.83 69 (56, 78) $P=0.66$	19 (63.33)	5 (16.13) $P=0.14$	3 (9.68) $P=0.68$	23 (74)	7 (23)	1 (3)
Transverse colon (n=28)	69.32±14.79 76 (59, 80) $P=0.16$	11 (39.29)	11 (39.29) $P=0.23$	7 (25) $P=0.078$	21 (75)	7 (25)	
Splenic flexure (n=15)	64.46±15.84 66 (51, 76) $P=0.6$	10 (66.67)	5 (33.33) $P=0.76$	1 (6.67)	13 (87)	2 (13)	
Previous/concurrent malignancy (n=23)	71.31±12.43 74 (64, 79) $P=0.046$	9 (39)	11 (47.83) $P=0.055$	6 (26.09) $P=0.064$	9 (39)	11 (48)	3 (13)
Distant metastasis (n=47)	66.46±14.23 67 (56, 78) $P=0.92$	25 (53.19)	5 (10.64) $P=0.01$	3 (6.38) $P=0.249$	14 (78)	4 (22)	
Other tumors (n=4)	66±4.83 67.5 (63, 69) $P=0.84$	2 (50)	0	1	4		
Multiple primary tumors (n=7)	75±10.63 79 (64, 83) $P=0.089$	3 (42.8)	1	1	5	2	
Acute intestinal obstruction (n=5)	74±6.12 74 (70, 76) $P=0.16$	2 (40)	0	1	4	1	
Previous colonic surgery (n=8)	76.6±7.96 78.5 (70.5, 81.5) $P=0.02$	1 (12.5)	6	1	0	7 (87)	1 (12)

BMI=body mass index. • Data are numbers with percentages in parentheses or means±standard deviations unless otherwise indicated.

Table 2. Intraoperative outcomes

	<i>Length of incision (cm)</i>	<i>Duration of surgery (min)</i>	<i>Conversion to open from laparoscopic</i>	<i>Intraoperative complication</i>	<i>Tumor size (cm)</i>	<i>No. of nodes</i>
	<i>Median (Q1, Q3)</i>	<i>Median (Q1, Q3)</i>			<i>Median (Q1, Q3)</i>	<i>Median (Q1, Q3)</i>
Inclusion group (n=221)	5.57±3.11 5 (4, 6)	172±65.03 160 (125, 195)	25 (11.3)	19 (8.6)	4.4±2.46 4 (3, 5.3)	11±7.57 10 (6, 15)
Exclusion group (n=166)	6.95±5.37 5 (5, 6.8) <i>P</i> =0.0019	180±64.44 170 (140, 210) <i>P</i> =0.122	38 (23) <i>P</i> =0.0023	15 (9.04) <i>P</i> =0.88	5.14±4.18 4.5 (3.3, 6) <i>P</i> =0.14	12.94±10.16 10 (6, 16) <i>P</i> =0.302
BMI > 30 (n=28)	9.23±9.74 5 (5, 8) <i>P</i> =0.074	187.5±55.37 172 (145, 215) <i>P</i> =0.146	9 (32.14) <i>P</i> =0.006	4 (14.29) <i>P</i> =0.305	4.94±3.24 4.3 (3, 6) <i>P</i> =0.43	10.64±5.87 9 (6, 14) <i>P</i> =0.94
T4 (n=31)	7.47±5.95 5 (4.6, 6.8) <i>P</i> =0.19	182±58.35 175 (150, 222) <i>P</i> =0.33	9 (29) <i>P</i> =0.02	2 (6.45) <i>P</i> =1	6.5±3.8 6 (4, 7.5) <i>P</i> =0.001	15.89±12.86 12 (8.5, 18) <i>P</i> =0.084
Transverse colon (n=28)	6.54±3.28 5 (4.5, 7) <i>P</i> =0.152	204.27±59.78 205 (150, 225) ^c <i>P</i> =0.017	7 (25) <i>P</i> =0.065	3 (10.71) <i>P</i> =0.722	6.84±8.3 4 (2.6, 7) <i>P</i> =0.415	12.84±10.27 10 (5, 18) <i>P</i> =0.67
Splenic flexure (n=15)	5.6±2.14 5 (5, 6) <i>P</i> =0.56	185.8±74.96 162 (135, 240) <i>P</i> =0.59	1 (6.67) <i>P</i> =1	1 (6.67) <i>P</i> =1	4.81±1.79 4.5 (3.5, 6) <i>P</i> =0.34	14.36±13.27 11.5 (9.5, 15) <i>P</i> =0.44
Previous/concurrent malignancy (n=23)	8.02±6.59 6 (4, 8) <i>P</i> =0.103	183±61.34 173 (140, 200) <i>P</i> =0.35	6 (26) <i>P</i> =0.091	6 (26) <i>P</i> =0.02	4.35±1.79 4.3 (3.2, 5.2) <i>P</i> =0.84	12.58±7.08 11 (8, 15) <i>P</i> =0.33
Distant metastasis (n=47)	6.52±4.57 6 (5, 6.25) <i>P</i> =0.014	165.1±63.01 160 (120, 210) <i>P</i> =0.92	10 (21.28) <i>P</i> =0.065	3 (6.38) <i>P</i> =0.77	5.102±2.41 4.5 (4, 6) <i>P</i> =0.07	10.9±10.12 9 (6, 12) <i>P</i> =0.25
Other tumors (n=4)	6.6±1.5 6.8 (5, 8)	135±18.02 140 (115, 150)	1 (25)	0	3.5±1 3 (3, 4)	9.5±9.19 9.5 (3, 16)
Multiple primary tumors (n=7)	8±4.69 6 (5.5, 10.5)	308.3±136.59 270 (195, 460)	4 (57.14)	1 (14.2)	10.25±16.15 4.25 (2, 6.5)	18.66±14.56 16.5 (11, 19)
Acute intestinal obstruction (n=5)	6.17±0.35 6 (6, 6.35)	170±70.71 145 (120, 220)	0	0	5.25±1.55 4.75 (4.25, 6.25)	7.75±3.5 7.5 (5, 10.5)
Previous colonic surgery (n=8)	9±4.54 8 (5.5, 12.5)	211.6±74.67 185 (150, 275)	4 (50)	1 (12.5)	3.78±1.99 4 (2, 5.5)	11.57±5.25 13 (10, 14)

BMI=body mass index. • Data are means±standard deviations or numbers with percentages in parentheses unless otherwise indicated.

previous/concurrent malignancy were found to have a significantly higher rate of intraoperative complications (26 percent for EG vs. 8.6 percent for IG; *P*=0.023).

The EG had a significantly higher conversion rate (23 percent for EG vs. 11.3 percent for IG; *P*=0.0023). When using logistic regression to adjust for “effect of surgeon” on conversion rate in the two groups, the odds of conversion remained higher in the EG with an adjusted odds ratio of 2.33 (95 percent confidence interval (CI), 1.33–4.09). Reasons for conversion are shown in Table 3. Rates of conversion in patients belonging to the BMI > 30 (32.1 percent conversion rate) and T4 (29 percent conversion rate) subgroups were significantly higher compared with the IG (*P*=0.006 and *P*=0.02, respectively). Patients belonging to the “previous colonic surgery” and “multiple primary tumors” subgroups had the highest conversion rates, but no formal statistical testing was conducted because of small sample size. Stage IV and transverse colon patients had a 21 and 25 percent conversion rate, respectively, which trended toward but did not reach statistical significance (*P*=0.065 and *P*=0.065, respectively) compared with the IG.

Incision lengths was significantly higher in the EG (7 vs. 5.6 cm; *P*=0.0019). The only subgroup with a significantly longer incision was Stage IV patients (6.5 vs. 5.6 cm; *P*=0.014).

When examining intraoperative complication rates over time, there was no difference found in the inclusion group. When the exclusion group was considered, there was a higher rate in the most recent five years of the database (13.4 percent) compared with the previous ten years.

Postoperative Outcomes

There was no difference found in the overall complication (intraoperative and postoperative) rate between the EG and IG (38 percent for EG vs. 33 percent for IG; *P*=0.32; Table 4). Adjustment for effect of surgeon did not affect this result. In addition, there was no difference seen when comparing postoperative complication rates (33.7 percent for EG vs. 26.7 percent for IG; *P*=0.13). Postoperative complications included hemorrhage, wound infection, anastomotic leak, abscess, urinary retention or infection, ileus, bowel obstruction, deep vein thrombosis, pulmonary (pneu-

Table 3. Reasons for conversion

Conversion reason	Inclusion group	Exclusion group	Total
Adhesions	5	8	13
Tumor-related	4	15	19
Mobilization/localization issue	6	3	9
Hemorrhage	3	4	7
Bowel injury	2	2	4
Anesthesia/patient-related	2	5	7
Instrument failure	1	0	1

monia, atelectasis), cardiac complications (arrhythmia, myocardial infarction, congestive heart failure), and mortality. Postoperative mortality was considered to be mortality before discharge from hospital.

Major complications were considered to be hemorrhage, anastomotic leak, abscess, deep vein thrombosis, cardiac complications, ischemic gut, liver failure, syndrome

of inappropriate antidiuretic hormone secretion (SIADH), cholecystitis, and pneumonia. Furthermore, when major complications are considered separately there was no difference (15.7 percent for EG vs. 13.1 percent for IG; $P=0.19$) between the two groups (Table 3). Two subgroups—BMI > 30 (46.4 percent) and transverse colon cancers (46.4 percent)—had higher rates of postoperative complications ($P=0.03$ and $P=0.03$, respectively).

No significant difference was found with regard to median days to discharge (5 days for EG vs. 5 days for IG; $P=0.36$) or days to regular diet (4 days for EG vs. 4 days for IG; $P=0.49$). None of the subgroups in the exclusion group had significantly longer length of stay or days to regular diet. Postoperative mortality rates were similar in the two groups (4.8 percent for EG vs. 4.1 percent for IG; $P=0.72$). There were no subgroups identified with a significantly increased postoperative mortality rate.

Of the 387 patients, 62 percent had long-term oncologic data included in the database. There was no difference in

Table 4. Postoperative outcomes

	Overall complications*	Postoperative complications [†] Major [‡]	Days to diet as tolerated Median (Q1, Q3)	Days to discharge Median (Q1, Q3)	Postoperative mortality [§]
Inclusion group (n=221)	73 (33.03)	59 (26.7)	4.34±2.96	6.76±5.36	9 (4.07)
Exclusion group (n=166)	63 (37.95)	29 (13.12)	4 (3, 4.5)	5 (4, 7)	8 (4.82)
	$P=0.315$	56 (33.7)	4.78±3.58	7.58±6.85	
		$P=0.13$	4 (3, 5)	5 (4, 8)	$P=0.72$
		$P=0.187$		$P=0.36$	
BMI > 30 (n=28)	15 (53.57)	13 (46.43)	4.39±2.04	5.96±2.99	1 (3.57)
	$P=0.032$		4 (3, 6)	5 (4, 7)	
		$P=0.03$	$P=0.44$	$P=0.95$	$P=0.703$
T4 (n=31)	14 (45.16)	13 (41.94)	5.04±4.61	7.7±6.81	0
	$P=0.18$		4 (3, 5)	5 (4, 9)	
		$P=0.078$	$P=0.65$	$P=0.61$	
Transverse colon (n=28)	14 (50)	13 (46.43)	5.23±2.53	8.15±7	1 (3.57)
	$P=0.076$		5 (3, 5)	6.5 (4, 9)	
		$P=0.03$	$P=0.029$	$P=0.146$	$P=1$
Splenic flexure (n=15)	4 (26.67)	4 (26.67)	5.78±5.56	9.66±13.76	1 (6.67)
	$P=0.77$		4 (3, 5)	5 (3, 6)	
		$P=1$	$P=0.36$	$P=0.64$	$P=0.48$
Previous/concurrent malignancy (n=23)	11 (47.83)	9 (39.13)	4.61±2.59	9.4±9.4	2 (8.7)
	$P=0.155$		3 (3, 5)	5 (4, 11)	
		$P=0.205$	$P=0.68$	$P=0.57$	$P=0.28$
Distant metastasis (n=47)	12 (25.53)	11 (23.4)	3.61±1.66	6.97±5.17	3 (6.38)
	$P=0.315$		3 (2, 5)	5 (4, 7.5)	
		$P=0.64$	$P=0.125$	$P=0.748$	$P=0.44$
Other tumors (n=4)	1 (25)	1 (25)	5±2.64	7.6±2.08	0
			6 (2, 7)		
Multiple primary tumor (n=7)	3 (42.86)	2 (28.57)	—	14.66±17	1 (14.29)
				8 (6, 12)	
Acute intestinal obstruction (n=5)	1 (40)	1 (40)	6±3.16	9.8±7.85	0
			6.5 (3.5, 8.5)	6 (5, 11)	
Previous colonic surgery (n=8)	3 (37.5)	3 (37.5)	4.16±2.56	9.62±11.77	0
			3 (3, 5)	5 (3, 9)	

BMI=body mass index. • Data are numbers with percentages in parentheses or means±standard deviations unless otherwise indicated. • * Overall complications included intraoperative and postoperative complications. • † Postoperative complications included hemorrhage, wound infection, leak, abscess, urinary retention, ileus, bowel obstruction, deep vein thrombosis, pulmonary, cardiac, and mortality. • § Postoperative mortality is mortality before discharge from hospital. • ‡ Major complication included hemorrhage, leak, abscess, DVT, cardiac, ischemic gut, liver failure, SIADH, cholecystitis (DVT) and pneumonia.

number of patients followed up between the two groups (62 percent for IG vs. 61 percent for EG; $P=0.75$). A difference was detected in median length of follow-up (423 days for IG vs. 299 for EG; $P=0.016$). A Cox proportional hazard model adjusting for TNM stage and age demonstrated that there was no survival difference detected between the groups at two years ($P=0.8$; Fig. 3). There was a paucity of data to provide a robust estimate for five-year survival and therefore was not included.

DISCUSSION

Laparoscopic colon resection for patients who fall outside of the inclusion criteria that were outlined in the COST and COLOR trials seems to be safe. When comparing inclusion and exclusion groups, there were no differences found with regard to intraoperative or postoperative complications, operative time, postoperative mortality, and two-year survival. Conversion rate and incision length were significantly higher in the exclusion group.

The perioperative outcomes are similar in the two groups. Complications were examined closely; when looking at operative, overall postoperative, and major complications postoperatively, there are no differences detected. The spectrum of complications is similar between the two groups except for two wound dehiscences in the exclusion group: surprisingly neither of these patients was converted and dehiscences occurred through the extraction incision. Both patients were Stage III patients. There was a higher rate of postoperative complications in the T4 and BMI > 30 group. These patients are still being approached laparoscopically at our institution considering that the length of stay and postoperative mortality rate are similar to the other subgroups. These patients could potentially be at a high risk of post-

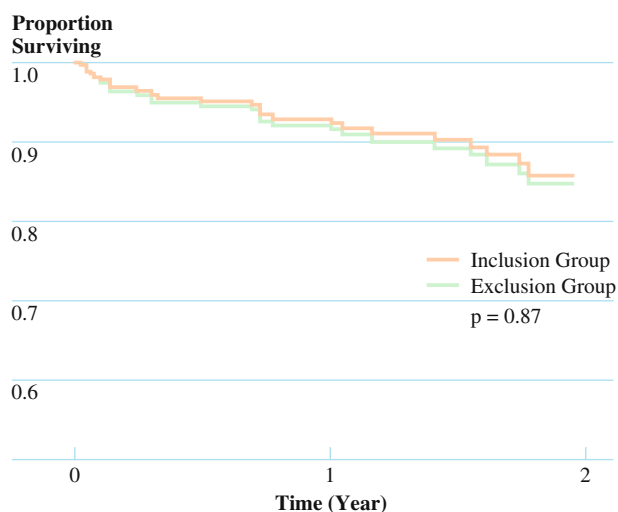
operative complication with an open approach, and the BMI > 30 group had significantly higher cardiac and pulmonary comorbidities than other subgroups. Although the postoperative complication rate was high, it could have been potentially higher with an open approach; however, the data available in this study are not sufficient to answer this question. More than half the complications in both groups were minor complications, such as wound infection, ileus, and transient increase in creatinine. The plan is to continue to monitor outcomes in these groups closely because they seem to be at a higher risk for postoperative complications according to the findings in this study.

The conversion rate in the exclusion group was twice that of the inclusion group. When the reasons for conversion are examined, it is apparent that the likely cause of this was presence of more advanced tumors in this group because almost half of the conversions in the exclusion group were the result of tumor factors, such as fixation or invasion of adjacent structures. This also seems to be the reason for the Stage IV subgroup having a conversion rate of 21 percent. It does not seem that the increased number of previous abdominal surgeries in the exclusion group was a factor in the increased conversion rate. When looking at reasons for conversion, adhesions did not seem to be responsible for the difference seen between the two groups. The other issue with conversion is the increased conversion rate in the last five years, which is clearly caused by the high conversion rate in the exclusion group during this same time period. In discussion with the surgeons involved with this study, it seems that there has been a greater referral of more complex patients. Because all cases were approached laparoscopically since the inception of this database, it does not seem that the reason for the increased conversion rate would be the result of selection of patients.

Operative time is an issue with laparoscopic colon surgery and the one subgroup that did have a high operative time was the transverse colon group. When this group is looked at closely, there was a high conversion rate in this group of 25 percent but no other contributing factors could be found regarding the relatively high operating time.

One question the reader may ask is why the COST and COLOR trials were chosen. COST was the trial that many surgeons point to with regard to changing practice especially in North America. COLOR is the trial that many surgeons think of when considering trials from Europe. When one examines the exclusion criteria from these studies, it is evident that there is a great deal of overlap. It should be noted these trials were chosen *a priori* of examination of our data. Rectal cancers were excluded in the COST and COLOR trials, and patients with rectal cancer were not included in this study. There were two main reasons for this: 1) there are large multicenter, randomized, controlled trials that are and will be examining long-term outcomes with regard to rectal cancer and whereas colon cancer resections are now considered oncologically safe, the same cannot be

FIGURE 3. Two year adjusted Survival comparing Inclusion to Exclusion group.



said of laparoscopic resections for rectal cancer; and 2) rectal cancer differs from colon cancer with regard to prognosis, recurrence patterns, and sexual dysfunction. There also are issues with regard to rectal cancer in terms of whether the lesion is a < 5 cm from the anal verge compared with those are more proximal. With the multitude of additional factors requiring consideration when examining rectal cancers, restricting this study to colon cancer seemed to be logical and provides a more meaningful message to surgeons in practice.

The limitations to this study include the fact that the four surgeons are all very experienced laparoscopically and this affects the generalizability of the results. Although data was well collected during the perioperative period, one can see that the long-term data is not complete because 38 percent of patients lack this information. There was no differential in the number of patients followed up when comparing the two groups. Not surprisingly, there was a difference in length of follow-up as the exclusion group had a lower median follow-up likely because of the Stage IV patients included in this group. The length of follow-up is reasonable in terms of giving a good prediction of two-year survival, but the data were not complete enough to give an accurate prediction regarding five-year survival. There also is no information regarding the American Society of Anesthesiologists status of the patients in this study.

The strengths of the study are the fact that prospectively collected data were used that were complete and detailed. In addition, there is no selection bias with regard to patients who were offered a minimally invasive approach because all patients presenting to these surgeons were approached laparoscopically. This study also represents a large series of patients and no other studies were found in the literature addressing this question.

Clearly there are a number of patients who fall outside the inclusion criteria for the large randomized trials conducted and surgeons are going to see a lot of patients who would not meet these criteria. Understanding outcomes in these patients is important as this study demonstrates that approximately 40 percent of patients would have been excluded from the COST and COLOR trials. Are the outcomes from a trial, such as COST, generalizable to these excluded patients and should these patients be offered a laparoscopic resection? The answer to both these questions seems to be "yes." The higher conversion rate would indicate that these cases are technically more difficult, likely related to tumor factors, but it would seem these can be completed laparoscopically and completed with satisfactory perioperative outcomes.

The cases that fall in the excluded group do not seem to be cases that should be performed by surgeons embarking on performing laparoscopic resections for the first time; the surgeons in this study were experienced and, as mentioned, have been approaching all colorectal cases laparoscopically. It would be interesting to see other series regarding these

types of patients and how results compare to the ones found in this study especially series with longer follow-up of patients to obtain more accurate five-year survival data.

CONCLUSIONS

Laparoscopic resections in colon cancer patients with T4 tumors, previous/concurrent malignancy, high BMI, previous colonic surgery, splenic flexure/transverse colon cancers, acutely obstructed, and Stage IV disease seems to be safe in experienced hands. Although BMI > 30 (a subgroup with significantly higher cardiac and pulmonary comorbidities) and T4 subgroups had a higher postoperative complication rate, the length of stay and mortality rates were similar to the other subgroups. Perioperative and available long-term data in this study seem to suggest that patients in the exclusion group have no difference in outcomes compared with patients who meet the inclusion criteria of large randomized trials. Further studies and longer follow-up data on this patient population are needed.

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