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Laparoscopy-assisted versus open colectomy for treatment of colon cancer in the elderly: morbidity and mortality outcomes in 545 patients

Francesc Vallribera Valls · Filippo Landi · Eloy Espín Basany · José Luis Sánchez García · Luis Miguel Jiménez Gómez · Marc Martí Gallostra · Luis Salgado Cruz · Manuel Armengol Carrasco

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Abstract
Background Advanced age is a risk factor of major abdominal surgery due to diminished functional reserve and increased comorbidity. Laparoscopy-assisted colectomy is a well-established procedure in colon cancer surgery. The aim of this study was to compare early outcome of elective laparoscopy surgery and open colectomy in colon cancer patients according to age.
Methods A total of 545 patients with colonic adenocarcinoma underwent elective surgery between 2005 and 2009. There were 277 patients in the laparoscopic group and 268 in the open. Patient characteristics in both groups were homogeneous and further stratified into three subgroups by age: <75, between 75–84, and ≥85 years. Main outcome measures were early morbidity, mortality, and hospital stay.
Results Open surgery group showed a higher overall morbidity rate (37.3 vs. 21.6 %, $P = 0.001$), medical complications (16.4 vs. 10.5 %, $P = 0.033$), surgical complications (23.5 vs. 15.5 %, $P = 0.034$), and mortality (6.7 vs. 3.2 %, $P = 0.034$). The overall morbidity rate difference between open and laparoscopy approach disappeared in the oldest group (≥85 years old). Surgical site infections rate was inferior for patients <75 years old in laparoscopy group compared with open. Mortality was also significantly inferior in laparoscopy group in younger patients (<75 years, 0 vs. 3 %, $P = 0.038$). Mean hospital stay was shorter for patients in <75 and 75–84 groups with laparoscopic approach (7.8 vs. 11.4 days and 10 vs. 14.3, respectively, $P = 0.001$) as compared with those who underwent open surgery, but these differences disappeared in patients aged ≥85 years.
Conclusion Laparoscopy-assisted colectomy in patients underwent elective surgical resections for colon cancer showed advantages in rate of early complications in patients younger than 85 years of age and was found to be as safe and well tolerated as open surgery in patients over 85 years of age.

Keywords Elderly patients · Colon cancer · Laparoscopy-assisted versus open colectomy · Morbidity and mortality

Colorectal cancer is the second leading cause of cancer-related death in men and women in developed countries. The risk of colorectal cancer is the highest around age of 70, and 75 % of colon tumors are found in patients aged 65 years or older [1]. With the increase of age in the general population in developed countries the next future decades, the number of elderly patients who present with this disease will increase [2]. Unfortunately, most elderly patients who develop colonic cancer also have other comorbidities such as cardiovascular and pulmonary diseases, which increase the operative risk and

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F. Vallribera Valls · F. Landi (✉) · E. Espín Basany · J. L. Sánchez García · L. M. Jiménez Gómez · M. Martí Gallostra · L. Salgado Cruz · M. Armengol Carrasco
Unit of Colorectal Surgery, General and Digestive Surgery Department, Hospital Universitario Vall d'Hebron, Passeig Vall d'Hebron 119-129, 08035 Barcelona, Spain
e-mail: pippo.landi@gmail.com

F. Vallribera Valls
e-mail: 20412fvv@comb.cat

F. Vallribera Valls · F. Landi · E. Espín Basany · J. L. Sánchez García · M. Armengol Carrasco
Universidad Autonoma de Barcelona, Barcelona, Spain

the risk of postoperative morbidity and mortality [3]. Other factors that contribute to poor outcome of surgery in the elderly are delayed presentation and more advanced disease [4]. However, despite a growing body of data supporting that treatment outcome in older patients with colorectal cancer can be similar to that of their younger counterparts, further work is still needed to establish optimal strategies to care for this special population [5–7].

The use of a laparoscopic approach for colorectal malignancy treatment has become common and more widely available. It has been shown that laparoscopic-assisted colectomy lowers surgical trauma, decreases perioperative complications, and leads to more rapid return to normal activity [8, 9]. Evidence is growing that this approach is not only safe and feasible, but also long-term results, in terms of tumor recurrence and cancer-related surgical, are at least as good as those after open surgery as long as established oncologic principles are respected [10–15].

However, comparative data of laparoscopy-assisted versus open colectomy for elective surgery in elderly patients with non-metastatic colon cancer are still limited. Therefore, the objective of this study was to assess the influence of the surgical approach, i.e., laparoscopy-assisted colectomy versus open colectomy, on morbidity and mortality according to age, especially in patients older than 85 years.

Patients and methods

We conducted a retrospective review of all consecutive patients undergoing elective surgery for primary colon cancer at our institution between January 2005 and May 2009. Inclusion criteria were histologic confirmation of adenocarcinoma and tumor location 15 cm above the anal verge. Exclusion criteria were as follows: previous colonic surgery, evidence of tumor recurrence, metastatic disease (stage IV), multivisceral resection, total colectomy, ASA 4, and synchronous cancer.

The Ethics Committee of the hospital approved for retrospective review of medical records.

Preoperative evaluation included physical examination, colonoscopy and/or virtual colonoscopy, abdominal computed tomography, chest X-ray, and laboratory data including complete blood cell count, biochemical profile, and tumor markers (carcinoembryonic antigen CEA and cancer antigen 19.9). Between January 2005 and December 2007, patients were preoperatively prepared with anterograde intestinal cleansing (polyethylene glycol), and from January 1, 2008, this was substituted with preoperative cleansing enemas. All patients received antibiotic prophylaxis according to guidelines of the Infection Control Committee of the hospital.

The laparoscopic surgery program at our center began in 2005 and had a gradual introduction to the end of 2007. During this period, patients underwent laparoscopy-assisted colectomy or open colectomy according to the preferences of the surgeon in charge. From 2008 and after completing the training of the surgical team in laparoscopic procedures, a unified approach for laparoscopy-assisted colonic resection was developed.

Patients included in the study were divided into two groups according to the operative procedure: laparoscopy-assisted colectomy and open colectomy. Patients in both groups were further stratified by age (<75, 75–84, ≥85 years old). The following variables were recorded to assess homogeneity of the study groups: sex, POSSUM (Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity) score [16], American Society of Anesthesiologists Physical Status classification (ASA), postoperative stage according to the classification of the American Joint Committee on Cancer and International Union against Cancer stage classification [17], tumor location including the sigmoid colon, descending colon, splenic flexure, and on the right side (cecum, ascending colon, and hepatic flexure), and surgical procedure, such as sigmoidectomy, left colectomy, and right and extended right colectomy.

Morbidity and mortality variables included wound local complications (hematoma/seroma formation, abdominal evisceration); general complications (cardiovascular, nephrourinary, respiratory, vascular, digestive); and surgical complications (suture dehiscence defined as any clinical and/or radiologic evidence of contrast leak and/or perianastomotic air, surgical site infection, hemoperitoneum, postoperative paralytic ileus, and reoperation (within 30 days after surgery). The length of hospital stay was calculated as the difference between date of discharge from the hospital and date of operation. Patients that initially were classified in laparoscopic group and then required conversion to open surgery were analyzed as part of the initial study group.

Data were assessed according to the intention-to-treat principle. Categorical variables are expressed as frequencies and percentages and continuous variables as mean value. Differences in the study variables between laparoscopic and open surgery groups were assessed with the Chi square (χ^2) test and the Yate's correction when necessary for categorical data, and the Student's T test and the Mann–Whitney's U test for quantitative data. Statistical significance was set at $P < 0.05$.

Results

A total of 662 patients with histologically proven adenocarcinoma of the colon received surgical treatment at our institution between January 2005 and May 2009.

Table 1 Characteristics of the study population according to surgical approach and age

	<75 years of age ($n = 278$)			Between 75 and 84 years of age ($n = 177$)			≥85 years of age ($n = 90$)		
	Laparoscopy	Open surgery	*P* value	Laparoscopy	Open surgery	*P* value	Laparoscopy	Open surgery	*P* value
No. of patients	143	135		89	88		45	45	
Female patients	57 (39.9)	47 (34.8)	0.385	32 (35.9)	32 (36.4)	0.601	14 (31.1)	13 (28.8)	0.368
POSSUM[a] score, mean	16.3	17.9	0.378	19.8	21.1	0.078	20.6	21.0	0.373
ASA[b] status									
I	24 (16.8)	17 (12.6)	0.584	6 (6.8)	5 (5.7)	0.214	0	1 (2.2)	0.538
II	85 (59.4)	82 (60.7)		29 (32.6)	40 (45.5)		24 (53.3)	25 (55.6)	
III	34 (23.8)	36 (26.7)		54 (60.6)	43 (48.8)		21 (46.7)	19 (42.2)	
Tumor staging									
0	5 (3.4)	7 (5.2)	0.918	6 (6.7)	4 (4.5)	0.597	4 (8.9)	2 (4.5)	0.529
I	20 (14)	18 (13.3)		15 (16.8)	19 (21.6)		6 (13.3)	4 (8.9)	
IIA	46 (32.2)	39 (28.9)		31 (34.9)	26 (29.6)		13 (28.9)	26 (57.6)	
IIB	21 (14.7)	17 (12.6)		9 (10.1)	12 (13.6)		8 (17.8)	3 (6.7)	
IIIA	18 (12.6)	23 (17)		12 (13.5)	11 (12.5)		2 (4.5)	2 (4.5)	
IIIB	19 (13.3)	19 (14.1)		9 (10.1)	11 (12.5)		6 (13.3)	6 (13.3)	
IIIC	14 (9.8)	12 (8.9)		7 (7.9)	5 (5.7)		6 (13.3)	2 (4.5)	

Percentages in parenthesis

[a] Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity

[b] American Society of Anesthesiologists

However, 117 (17.7 %) were excluded owing to: distant metastasis in 47 patients, synchronous cancer in 22, tumor recurrence in 21, total colectomy in 15, and multivisceral resection in 12. Therefore, 545 patients took part in the study, 277 in the laparoscopic surgery group and 268 in the open surgery group. Patients in both groups were further stratified according to age as shown in Table 1. Overall, there were 278 (51 %) patients under 75 years of age, 177 (32.5 %) aged between 75 and 84 years, and 90 (16.5 %) were 85 years or older. Also, female patients accounted for 35.8 % of the patients. There were no statistically significant differences in the distribution of female patients according to age neither in the laparoscopic surgery group ($P = 0.516$) nor in the open surgery group ($P = 0.368$). Moreover, patients in both study groups were homogeneously distributed in relation to preoperative POSSUM score, ASA status, tumor stage, tumor localization, and type of operation (Tables 1, 2). In 255 cases (46.8 %), the tumor was found in the right colon and in 207 (38 %) in the sigmoid colon. Differences in the tumor site between patients undergoing laparoscopic surgery or open surgery were not found ($P = 0.935$) (Table 2). In relation to the type of surgical procedure, right colectomy and sigmoidectomy were the most common both in the laparoscopic and open surgery groups ($P = 0.745$) (Table 2). Conversion to open surgery rate was globally 6.1 % (17 patients), homogenously distributed in subgroups by age: <75 years old, six patients (4.2 %); 75–84 years old, six patients (6.7 %); ≥85 years old, five patients (11.1 %). The differences were not statistically significant.

Table 2 Tumor location and surgical procedure according to the surgical approach

	Laparoscopic surgery ($n = 277$)	Open surgery ($n = 268$)	*P* value
Tumor location			
Sigmoid colon	103 (37.2)	104 (38.8)	0.935
Descending colon	31 (11.2)	23 (8.6)	
Splenic flexure	4 (1.4)	4 (1.5)	
Transverse colon	13 (4.7)	8 (3)	
Right colon	126 (45.5)	129 (48.1)	
Surgical procedure			
Sigmoidectomy	103 (37.2)	106 (39.6)	0.745
Left colectomy	36 (12.9)	27 (10)	
Right extended colectomy	9 (3.3)	6 (2.3)	
Right colectomy	129 (46.6)	129 (48.1)	

Percentages in parenthesis

The overall morbidity and mortality rates in the laparoscopy and open surgery groups are shown in Table 3. The open surgery group showed significantly higher percentages of overall morbidity (37.3 vs. 21.6 %, $P = 0.001$), medical complications (16.4 vs. 10.5 %, $P = 0.033$), and surgical complications (23.5 vs. 15.5 %, $P = 0.034$). The mortality

Table 3 Postoperative overall morbidity and mortality according to the surgical approach

	Laparoscopic surgery (n = 277)	Open surgery (n = 268)	*P* value
All complications	60 (21.6)	100 (37.3)	*0.001*
Medical complications	29 (10.5)	44 (16.4)	*0.033*
Wound complications	13 (4.7)	13 (4.8)	0.924
Surgical complications	43 (15.5)	63 (23.5)	*0.034*
Mortality	9 (3.2)	18 (6.7)	*0.034*

Percentages in parenthesis

Italicized values identifies a statistical significant difference between compared groups

rate was 6.7 % in the open surgery group and 3.2 % in the laparoscopy group ($P = 0.034$).

As shown in Table 4, patients underwent laparoscopy-assisted colectomy showed a significantly lower rate of overall morbidity as compared with open surgery, although this difference disappeared in the oldest group (≥85 years old). Medical complications, including cardiac, digestive, hematological, neurological, urinary, vascular, and respiratory events, were more common among patients in the open surgery group than in those undergoing laparoscopy-assisted procedures for the 75–84 years stratum (23.9 vs. 13.5 %) although did not reach statistical significance ($P = 0.076$). However, respiratory events were significantly less frequent in the laparoscopy group than in the open surgery group both in the <75 years (0.7 vs. 5.2 %, $P = 0.021$) and 75–84 years (4.3 vs. 12.7 %, $P = 0.031$) strata. The rate of local complications, among which hematoma of the surgical wound was the most frequent, was similar in the two study groups and across all age groups.

The distribution of surgical complications was also similar (Table 4). Ileus was the most frequent surgical-related complication especially in patients older than 85 years. Suture dehiscence was the most frequent cause of reoperation in 24 patients, ten in the laparoscopy group and 14 in the open surgery group. Hemoperitoneum was the second cause of reoperation, with two patients in each group. On the other hand, surgical site infection (wound infection) was significantly more frequent in the open surgery group than in the laparoscopy group only in youngest patients (<75 years old group, Table 4). The mortality rate adjusted by age was also significantly lower in patients <75 years old laparoscopy subgroup compared with open, without differences in 75–84 and ≥85 years old subgroups.

Table 4 Differences in morbidity, mortality, and length of hospital stay according to surgical approach and age

Data	<75 years of age (*n* = 278)			Between 75 and 84 years of age (*n* = 177)			≥85 years of age (*n* = 90)		
	Laparoscopy	Open surgery	*P* value	Laparoscopy	Open surgery	*P* value	Laparoscopy	Open surgery	*P* value
No. of patients	143	135		89	88		45	45	
All complications[a]	18.2	36	*0.001*	30.4	46.2	*0.029*	35.6	35.6	1
Medical	10 (7)	15 (11.1)	0.230	12 (13.5)	21 (23.9)	0.076	7 (15.6)	8 (17.7)	0.581
Wound complications	6 (4.2)	3 (2.2)	0.353	5 (5.6)	8 (9.1)	0.376	2 (4.4)	2 (4.4)	1
Hematoma	3 (2.1)	1 (0.7)	0.342	2 (2.2)	2 (2.3)	0.991	0	0	–
Seroma	2 (1.4)	1 (0.7)	0.596	2 (2.2)	4 (4.5)	0.398	1 (2.2)	2 (4.4)	0.557
Evisceration	1 (0.7)	1 (0.7)	0.967	1 (1.1)	2 (2.3)	0.554	1 (2.2)	0	0.153
Surgical complications	18 (12.6)	27 (20)	0.094	17 (19.1)	24 (27.3)	0.198	8 (17.8)	12 (26.7)	0.310
Hemorrhage	5 (3.5)	1 (0.7)	0.114	3 (3.4)	5 (5.7)	0.711	0	2 (4,4)	0.134
Paralytic ileus	3 (2.1)	8 (6)	0.110	2 (2.2)	6 (6.8)	0.431	3 (6.6)	7 (15.5)	0.115
Suture dehiscence	5 (3.5)	7 (5.1)	0.227	4 (4.5)	7 (8)	0.498	3 (6.6)	2 (4.4)	1
Reoperation	5 (3.5)	11 (8.1)	0.096	8 (9)	6 (6.8)	0.593	2 (4.4)	1 (2.2)	0.238
Surgical site infection	12 (8.4)	25 (18.5)	*0.013*	11 (12.4)	18 (20.5)	0.146	7 (15.5)	3 (6.7)	0.180
Superficial	3 (2.1)	12 (8.9)	*0.031*	3 (3.4)	9 (10.2)	0.175	1 (2.2)	1 (2.2)	1
Deep organ-space	9 (6.3)	13 (9.6)	0.225	8 (9)	9 (10.2)	0.981	6 (13.3)	2 (4.4)	0.798
Mortality	0	4 (3)	*0.038*	6 (6.7)	9 (10.2)	0.405	3 (6.7)	5 (11.1)	0.459
Length of hospital stay[b]	7.8	11.4	*0.001*	10	14.3	*0.001*	11.4	15.4	0.077

Percentages in parenthesis

Italicized values identifies a statistical significant difference between compared groups

[a] Expressed in percentages

[b] In days, mean value

Finally, the mean length of hospital stay was significantly shorter for patients in the <75 and 75–84 laparoscopy group (7.8 vs. 11.4 days and 10 vs. 14.3 respectively, $P = 0.001$) as compared with those underwent open surgery, but these differences disappeared in patients aged 85 years or older (Table 4).

Discussion

The burden of colorectal cancer morbidity and mortality falls largely on the elderly, who account for more than 70 % of colorectal cancer patients. Surgical outcomes are determined by complex interactions among a variety of factors including patient characteristics, diagnosis, and type of procedure. Surgical risk increases with age, primarily from frequent comorbidities and loss of cardiac and pulmonary reserve. Complications are also tolerated poorly by the elderly, emphasizing the importance of their prediction and prevention. Surgical risk in this population is significant, but with careful individualized preoperative assessment and perioperative management, acceptable morbidity and mortality are possible. Laparoscopic colectomy is now widely applied to treat cases of colorectal cancer supported by the evidence of equivalency of cancer-free and overall survival for open and laparoscopic resections [10, 13, 14, 18–21]. Furthermore, expanding the role of laparoscopy in the treatment of older patients with colon cancer should decrease the rate of postoperative complications [22]. Also, not only surgery should not be denied to elderly patients with colorectal cancer, but also enhanced recovery programs are feasible for colorectal surgery patients ≥80 years of age with similar compliance as the younger age group [23].

Data of the present study, which are consistent with previous studies [1, 2, 24], show that laparoscopy-assisted colectomy offers better results in terms of morbidity and length of hospital stay in patients younger than 85 years old. If preoperative assessment of comorbid conditions and perioperative care is ensured, laparoscopic procedures have been shown to be safe options in the elderly. Advanced age is no contraindication for laparoscopic colorectal surgery [25]. However, in the oldest old group (≥85 years), which accounted for 16.5 % of the study population, the use of the laparoscopic approach for elective colonic resection has not been associated with a decrease in morbidity or longer hospital stay compared with patients in the open surgery group.

The present retrospective, single-center study was conducted to compare the results obtained in the early postoperative period between elective colonic resection performed through the laparoscopy approach and the conventional open laparotomy, as well as to determine whether differences in early outcome may be expected according to ages of the patients and the type of surgical procedure. Patients included in the laparoscopy and open surgery groups were homogeneous in relation to total number of patients, male/female ratio, POSSUM score, ASA status, postoperative tumor stage, tumor location, and type of colonic resection. We found that the overall rate of morbidity, as well as medical complications and surgery-related complications were significantly more frequent among patients in the open surgery group, except for local complications which were similar in both study groups (Table 3). The mortality rate was also significantly higher in the open surgery group as compared with the laparoscopy group. As expected, length of stay in the hospital was more prolonged in the open surgery group. In general, the higher rate of complications among patients in the open surgery group occurred in patients younger than 85 years.

Conclusion

To the best of our knowledge, this is the first study comparing laparoscopic with open resection for colon cancer in elderly patients stratified by different groups of age. We report clinical information about ultra-octogenarians population that may be helpful in surgical decision-making. In summary, laparoscopy-assisted colectomy in patients undergoing elective surgical resections for colon cancer showed advantages in the rate of early complications in patients under 85 years of age and was found to be safe and well tolerated as conventional open surgery in patients over 85 years of age. Nowadays, age cannot be considered as a contraindication of laparoscopic surgery for colon cancer patients, although the use of laparoscopic surgery in the elderly should be individualized in order to offer the appropriate surgical approach minimizing damage to underlying conditions, which are the main cause of death in this subgroup of patients.

Disclosures Francesc Vallribera Valls, Filippo Landi, Eloy Espín Basany, José L. Sánchez García, Luis M. Jiménez Gómez, Marc Martí Gallostra, Luis Salgado Cruz and Manuel Armengol Carrasco have no conflicts of interest or financial ties to disclose.

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