Laparoscopic vs. open resection for colon cancer-quality of oncologic resection evaluation in a medium volume center

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Abstract. Despite concerns regarding oncologic safety, laparoscopic surgery for colon cancer has been proven in several trials in the lasts decades to be superior to open surgery. In addition, the benefits of laparoscopic surgery can be offered to other patients with malignant disease. The aim of the present study was to compare the quality of oncologic resection for non-metastatic, resectable colon cancer between laparoscopic and open surgery in terms of specimen margins and retrieved lymph nodes in a medium volume center in Romania. A total of 219 patients underwent surgery for non-metastatic colon cancer between January 2017 and December 2020. Of these, 52 underwent laparoscopic resection, while 167 had open surgery. None of the patients in the laparoscopic group had positive circumferential margins (P=0.035) while 12 (7.19%) patients in the open group (OG) had positive margins. A total of three patients in the laparoscopic group (5.77%) and seven patients (4.19%) in the OG had invaded axial margins. While the number of retrieved lymph nodes was not correlated with the type of procedure [laparoscopic group 16.12 (14±6.56), OG 17.31 (15±8.42), P=0.448], the lymph node ratio was significantly higher in the OG (P=0.003). Given the results of the present study, it is safe to conclude that laparoscopic surgery is not inferior to open surgery for non-metastatic colon cancer in a medium volume center.

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Introduction

Laparoscopic surgery has long been regarded with concern for malignant disease, especially for colon cancer. The extent of resection, exploration for staging and trocar site recurrences are the main causes of concern (1). Since the first laparoscopic assisted interventions for colon cancer in the 1990s, a decade later two large multi-institutional trials, COST and COLOR, have established that laparoscopic surgery is not inferior and is an acceptable alternative to open surgery for non-metastatic, resectable colon cancer (2-4). Since the early years of laparoscopy, several technological advances have been made, ranging from improved laparoscopes that provide better visualization to wound protectors, devices for hemostasis and excellent mechanical suture. The inherent benefits of laparoscopic surgery should therefore be offered to patients with malignant disease that otherwise would have large incisions, longer hospital stays and possibly difficulty in returning to work.

During the last decades, the increasing numbers of laparoscopic interventions have led to increased confidence in this approach. In addition, several advances in understanding patterns of malignant dissemination and tumor biology have led to standardization of resection techniques (5,6). Complete excision of embryologic compartments than contain malignant tumors as complete mesocolic excision for colon cancer is now widely accepted, as is total mesorectal excision (TME) for rectal cancer (7,8). The standardization of techniques facilitates the shortening of the learning curve for laparoscopic colon resection for cancer (9).

The oncological clearance for colon cancer following surgery for non-metastatic, resectable colon cancer is

evaluated by lymph node harvest and confirmation of free circumferential and axial surgical specimen margins. (10-12).

The present study retrospectively evaluated the quality of non-metastatic colon cancer resections between two groups, laparoscopic and open surgery. Of the eight senior surgeons in the Department of Surgery of Elias University Emergency Hospital, two practice routinely laparoscopic colon resections.

Materials and methods

Between January 2017 and December 2020, 311 patients underwent interventions for colon cancer in the Department of Surgery, Elias Emergency University Hospital. The present study retrospectively studied the pathology reports and charts of 219 patients that had undergone elective procedures for uncomplicated, non-metastatic, resectable colon cancer, excluding patients operated on in an emergency setting. The present study focused on the quality of the resection. A total of 92 patients with metastatic colon cancer or complications such as bleeding, intestinal obstruction, perforation and peritonitis were excluded. The retrospective observational study was approved by the Elias University Emergency Hospital Ethics Committee (decision no. 13376/27.11.2021) and all patients provided written informed consent prior to surgery, both for surgery and for inclusion in any future research.

All studied patients had preoperative definitive diagnosis; biopsy-proven colon cancer. Colonoscopy and computerized tomography scan for complete staging were performed for every patient. The Elias Hospital Multidisciplinary Tumor Board approved the surgical management for each case. No in-hospital mortality was recorded.

All interventions, for both laparoscopic and open surgery, followed the no-touch isolation technique with primary vascular ligation (13) (Fig. 1). The no-touch isolation technique as a unit standard was used in every case. Complete mesocolic excision is not used routinely in Elias Emergency University Hospital, yet a wide excision of mesocolon was encouraged (Fig. 2). For laparoscopic surgery, standard endobags and small, protected transverse incisions were used to retrieve the specimen.

All interventions were completed by senior surgeons leading surgical teams that included general surgery residents. A total of two surgeons performed the interventions in the laparoscopic group. Each performed at least 30 laparoscopic colorectal operations prior to the current study period, thus having completed their learning curve (14). No conversion was recorded in the laparoscopic group.

The retrieved specimens were sent uncut to the pathologist and TNM edition 8 was used for staging (15).

The quality of resection was evaluated in terms of specimen margins, lymph node harvest and n-ratio defined as the number of positive (metastatic) lymph nodes divided by the total number of examined lymph nodes.

The pooled data was studied using ANOVA models and medians comparison for continuous data and t-test or chi-square test for variables that were normally distributed, as well as nonparametric tests for skewed data (Mann-Witney U Test) or Fisher's exact test. Correlations were tested using the Pearson method or Spearman's correlation. The results are listed in Tables I and II. $P<0.05$ was considered to indicate a statistically significant difference.

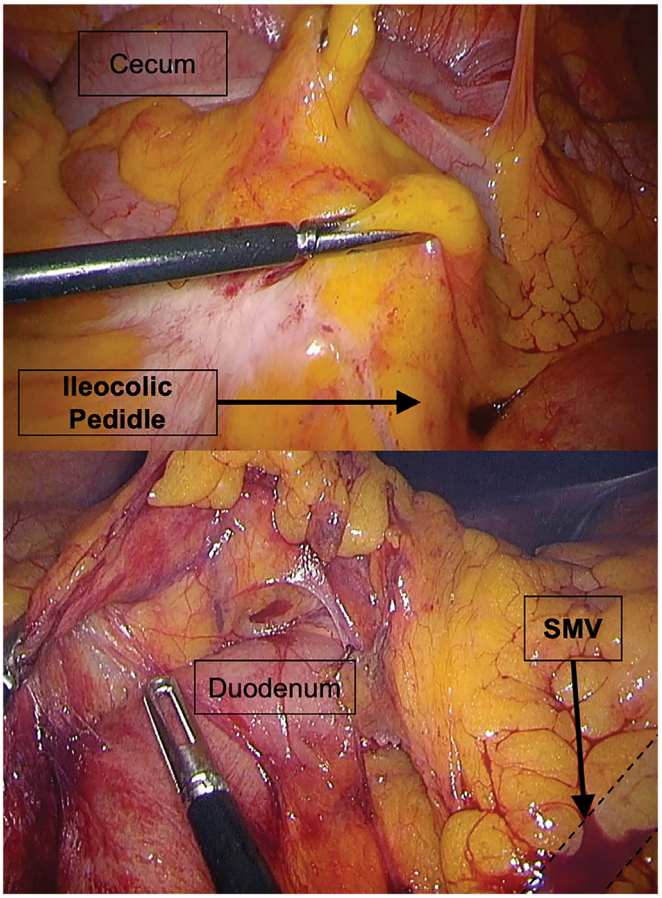

Figure 1. Right laparoscopic hemicolectomy. Identification and proximal dissection of the ileocolic pedicle and blunt dissection of the right mesocolon from the duodenum in the plane of Fredet's fascia. Note the highlighted course of the SMV. SMV, superior mesenteric vein.

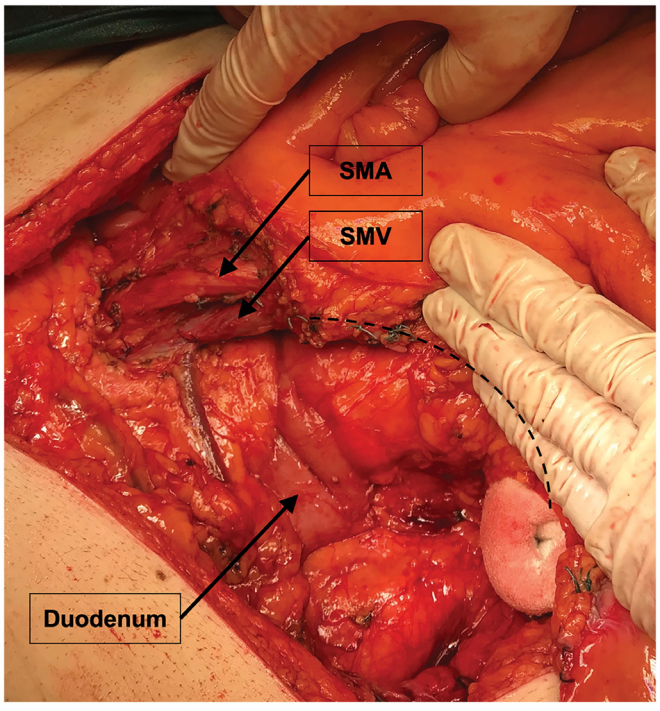

Figure 2. Open right hemicolectomy with complete mesocolic excision and D3 lymphadenectomy. Lymph node dissection around the SMA and SMV. Dotted line indicates medial resection line of mesocolon. SMA, superior mesenteric artery. SMV, superior mesenteric vein.

Table I. Patient demographics, tumor location, T stage (TNM 8th edition) and grading.

Characteristic	Laparoscopic Group (n=52)	Open Group (n=167)	P-value
Age			0.364
Mean age (years)	66.3	68.0	
Median (± standard deviation)	67 (±11.11)	68 (±11.52)	
Sex			**<0.001**
Female	18	83	
Male	34	84	
Tumor location			**<0.001**
Cecum	7	21	
Ascending colon	11	31	
Hepatic flexure	3	7	
Transverse colon	5	16	
Splenic flexure	1	15	
Descending colon	4	15	
Sigmoid colon	20	62	
T Stage			**0.003**
Tis	0	1	
T1	5	2	
T2	14	29	
T3	29	89	
T4a	2	30	
T4b	2	16	
Grading			0.636
G1	17 (32.69%)	43 (25.75%)	
G2	29 (55.77%)	95 (56.89%)	
G3	5 (9.62%)	26 (15.57%)	
G4	1 (1.92%)	3 (1.80%)	

Bold text indicates significance.

Results

Demographics, tumor location, T stage and grading are listed in Table I. The mean age of the patients in both groups was similar: 68 (±11.52) years in the open group (OG) and 66 (±11.11) years in the laparoscopic group (LG). There was a readiness for laparoscopic approach apparently in men but while this was not a randomized prospective study we can assume that more advanced disease or difficult interventions were expected in some female patients. As expected, fewer cases in the LG were recorded for difficult tumor locations (the splenic and hepatic flexures and descending colon as well as fewer advanced tumors) with only four T4 tumors in the LG.

As expected, a statistically significant number of more advanced tumors were recorded in the OG (r=0.2459, P=0.0003).

The mean number of harvested lymph nodes was 16.12 for the LG and 17.31 for the OG without statistical significance between groups (P=0.448). Although statistical significance between groups regarding total or mean number of harvested lymph nodes between groups was not found, the open interventions proved to be more constant in the number of harvested lymph nodes (ANOVA; P<0.0001).

While the mean number of invaded lymph nodes was 1.31 for the LG and 2.68 for the OG, the n-ratio was significantly lower in the LG (r=0.1324; P=0.003). N-ratio was corelated with T stage and as a higher number of advanced tumors were recorded in the OG, a higher n-ratio had to be expected. A significant correlation was observed between tumor grading and n-ratio in the LG that contained more less advanced tumors (r=0.2994, P=0.03), meaning that less advanced tumors were found in the LG.

No circumferential margins were found to be invaded in the LG while in the OG 12 specimens had invaded margins (7.19%; P=0.035). Axial margins were found to be invaded in three cases in the LG (5.77%) and seven cases in the OG (4.19%; P=0.637).

Circumferential margins proved to be more frequently free after laparoscopic interventions (r=0.1343; P=0.035). No significant correlations were found between groups regarding axial margins.

Discussion

The COST and COLOR trials proved that laparoscopic resections for colon cancer are by no means inferior to open

Table II. Oncologic resection overview.

Quality of resection parameters		Laparoscopic Group (n=52)	Open Group (n=167)	P-value
Harvested lymph nodes				
Mean		16.12	17.31	0.448
Median (± standard deviation)		14 (±6.632)	15 (±8.452)	
Invaded lymph nodes				
Mean		1.31	2.68	**0.015**
Median (± standard deviation)		0 (±2.397)	1 (±5.030)	
N-RATIO				
Mean	Mean	0.089	0.157	**0.003**
Median (± standard deviation)	Median (± standard deviation)	0 (±0.17)	0.03 (±0.23)	
Axial Specimen Margins				0.637
No	No	3	7	
Percentage	%	5.77%	4.19%	
Circumferential Specimen Margins				**0.035**
No		0	12	
Percentage		0	7.19%	

Bold text indicates significance.

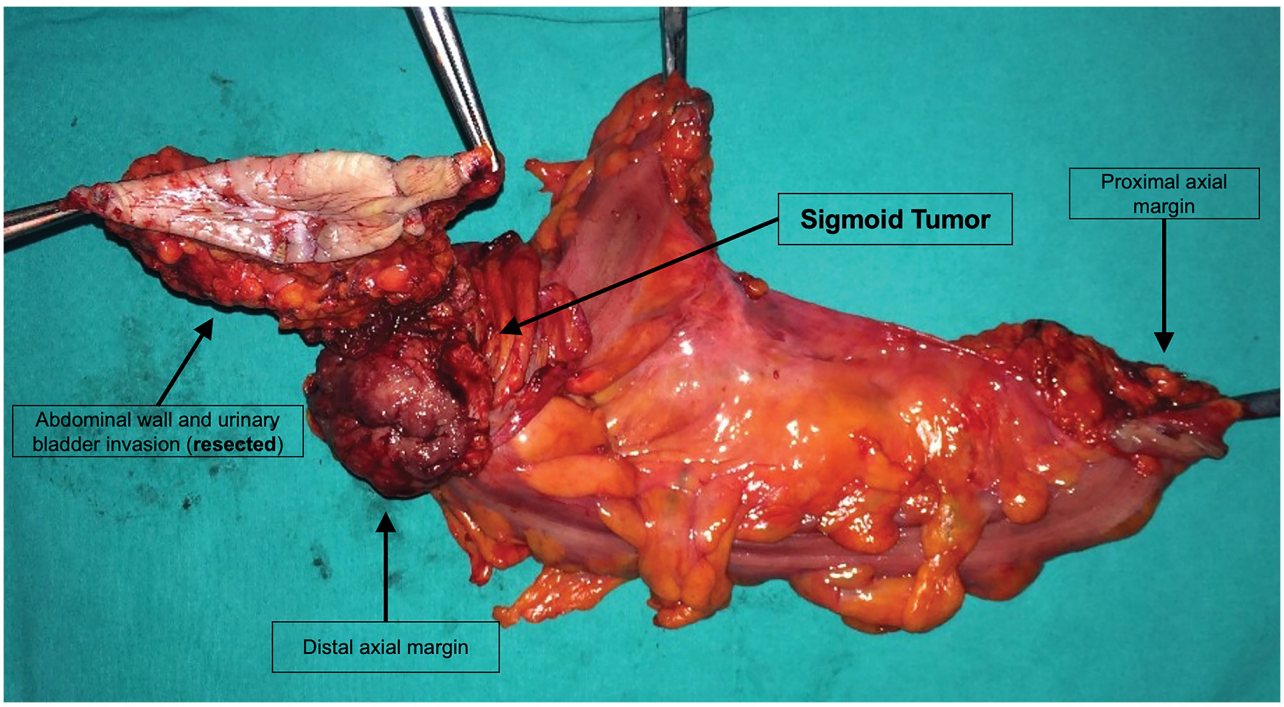

Figure 3. Multivisceral resection for sigmoid cancer with anterior abdominal wall and urinary bladder invasion. Negative axial and circumferential margins have been achieved by multivisceral resection.

resections but the routine of laparoscopic surgery still needs to be implemented (3,16). The uptake in laparoscopic resections for colorectal cancer in western countries is very encouraging, over a ten-fold increase in a period of less than 10 years, the largest increase being seen in high volume private hospitals (17). Exact figures for Romania have not been published but laparoscopic resections in the general surgery department of Elias Emergency University Hospital have been slowly increasing in the past 10 years from <7% to the current 31.13%.

As expected, morbidity and mortality for elective procedures decrease with volume size, facts suggested by numerous systematic reviews (18-20). Surgeon volume appears to be more important for interventions with a shorter length of stay while hospital volume is correlated with major interventions that

require longer length of stay and intensive care (21). Currently there is much debate around the case volume per surgeon to define high and low volumes. The conventionally accepted learning curve of 20 to 50 cases was overtaken by both senior surgeons in Elias Emergency University Hospital general surgery department that now routinely employ laparoscopic colorectal resections (22,23). Attaining advanced laparoscopic skills is mandatory for colon resections and as laparoscopic surgery is taught early on during residency a shorter learning curve should be expected. None of the of the surgeons whose patients are listed in the present study performed fewer than 7-10 elective colon resections per year, giving them a medium volume status. As for Elias University Emergency Hospital that houses our surgery department is fair to say it is in the same range of medium volume, with 219 elective colon resections in the last three years and 92 emergency interventions for complicated colon cancer in the same period (19).

Despite the fact that complete mesocolic excision was not routinely used in the surgery department at Elias Emergency University Hospital, the median number of harvested lymph nodes was higher than the published COST trial (3). The COLOR trial reported a median of 10 lymph nodes removed for both the laparoscopic and open resections (4). The number of recorded lymph nodes depends on the methods used for detection and in the present study, pathological dissection, palpation and careful naked eye examination were used; time consuming processes considering many metastatic lymph nodes are <5 mm in diameter. The Elias University Emergency Hospital Pathology Department does not use chemical fat clearance or entire residual mesenteric tissue examination in order to better define the lymph node yield, but then again this is not standard practice (24). Complete mesocolic excision promises an oncologically superior specimen than standard surgery for resectable colon cancer, with a median number of retrieved lymph nodes ranging between 18 and 30 (10). The number of retrieved lymph nodes was not linked with survival but lymph node ratio is an independent prognostic factor for colon cancer and is used to optimize staging (25,26). In the present study, taking all tumors into account, n-ratio was positively corelated with T stage (r=0,2151; P=0,001). In the LG, with less advanced tumors, n-ratio was corelated with tumor grading (r=0,2994; P=0,03) while in the OG, n-ratio was correlated with T stage (r=0,2045; P=0,008). The number of harvested lymph nodes was not significantly correlated with the type of surgery (P=0.448). However, there may be more factors that contribute to the number of excised lymph nodes, especially in laparoscopic procedures, such as previous abdominal surgery, BMI and tumor size and type, which may be of great interest for future studies, as is the case for in-depth comparison of postoperative complications, length of stay, the need for blood transfusions and disease recurrence.

Regarding the resection margins, surgeons in the general surgery department at Elias Hospital are encouraged to keep >5 cm distance from the tumor and extensive bowel resections are indicated when the tumor falls between large feeding vessels. In the present study, in 12 cases (7.9%) circumferential margins were microscopically invaded in the open group. To be noted that the OG contained 46 T4 tumors and additional visceral en-block resections were demanded (Fig. 3). None of the cases in the LG had positive circumferential margins, although four cases had advanced tumors. This could be explained by the augmented visualization and magnification of the laparoscopic camera and the employment of less blunt dissection than in open surgery. Axial resections margins were positive in a reasonable percentage both for the OG and LG.

The present study suggested that laparoscopic surgery is not inferior to open surgery for non-metastatic colon cancer in a medium volume center. With more experience, case load and other surgeons undertaking laparoscopic surgery for colon cancer, more patients may be offered the benefits of minimally invasive surgery.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

OE was responsible for the design of the study, supervised the collection of the data, and had a decisive contribution to the discussions. AA, VC, and ET made substantial contributions to conception, design and interpretation of data, IS, LT and AM contributed to the analysis and data interpretation. AT and RT collected and analyzed the data. LR, AB-S and DM were involved in the statistical data analysis and submission process. LT and AM supervised the research and contributed to the final version of the manuscript. All the authors confirm the authenticity of all the raw data. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The present study received approval from Elias University Emergency Hospital Ethics Committee (decision number 13376/27.11.2021).

Patient consent for publication

All patients provided written informed consent for the use of the data.

Competing interests

The authors declare that they have no competing interests.

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