Evaluation of early outcome of laparoscopic versus open left hemicolectomy in patients with left colon cancer

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Received: 16 October 2023
Revised: 27 October 2023
Accepted: 30 October 2023
Published: 31 January 2024

The Egyptian Journal of Surgery 2024, 43:224–229

Background
Colorectal cancer is a prominent global health concern, and while laparoscopic surgeries offer minimally invasive benefits, there is a noted underrepresentation of left-sided colon cancer in current research. This study seeks to bridge the gap by assessing the safety and efficacy of laparoscopic (LC) versus open left hemicolectomy (OC) in patients with left-side colon cancer.
Patients and methods
This prospective, nonrandomized study was conducted from May 2020 to May 2022 at Menoufia University Hospital and Damanhur Medical National Institute, enrolling 40 patients diagnosed with left-sided colonic carcinoma. Participants were divided into two groups: 20 underwent LC, and 20 had OC. The primary outcomes were operative time, blood loss, and incision length, with several secondary outcomes like analgesic needs and postoperative hospital stay.
Results
Both groups showed no significant differences in age, BMI, and other demographic characteristics. However, intraoperatively, the OC group completed procedures significantly faster than the LC group, with average times of 2.58 h compared with 4.48 h ($P<0.001$). Postoperatively, the LC group showed faster recovery, taking 2.35 days ($P=0.019$) to resume a liquid diet compared with 4.45 days for the OC group and 2.35 days ($P<0.001$) to pass the first flatus versus 3.45 days in the OC group. The LC group also had a shorter hospital stay, averaging 4.1 days compared with the OC's 8.75 days ($P<0.001$), and harvested a higher number of lymph nodes (13 vs. 11.85, $P<0.001$).
Conclusion
The findings of this study demonstrate that LC and OC were comparable as regards intraoperative and postoperative complications. On the other hand, LC was considered a good and effective method for resection of left colonic carcinoma as it has many benefits, such as early recovery and short hospital stay.

Keywords:
colon cancer, hospital stay, laparoscopic hemicolectomy, open surgery, operative time

Egyptian J Surgery 43:224–229

1110-1121

Introduction

Colorectal cancer (CRC) ranks third in global malignancy diagnoses and stands as the third primary cause of tumor-related mortalities [1,2]. Surgical intervention remains the primary therapeutic approach for CRC, with laparoscopic methods gaining prominence due to their less-invasive nature. While there are reservations regarding laparoscopic rectal cancer surgery, early endorsements for laparoscopic colon cancer surgery have been made by the National Comprehensive Cancer Network guidelines [3], drawing upon findings from major multicenter randomized controlled trials such as the Australasian Laparoscopic Colon Cancer Study trial [4], Clinical Outcomes of Surgical Therapy study [5], Medical Research Council Conventional versus Laparoscopic-Assisted Surgery in Colorectal Cancer trial, and the Colon Cancer Laparoscopic or Open Resection study [6,7]. These studies underscored the advantages of laparoscopic colectomies (LC) over traditional surgeries concerning short-term results like reduced incision lengths, minimized intraoperative bleeding, and faster postoperative recovery. Moreover, these studies affirmed the effectiveness of tumor extraction, revealing no marked disparity in prolonged tumor-associated outcomes when juxtaposed with open surgeries [8–11]. Such findings also received validation from the Cochrane Database of Systematic Reviews [12,13].

However, the representation of left-sided colon cancer in these studies is scant. For instance, only 113 (10.4%) participants in the Colon Cancer Laparoscopic or Open Resection study [8], 59 (7.4%) in the Medical Research Council Conventional versus Laparoscopic-Assisted Surgery in Colorectal Cancer, and 64 (7.4%) in the Clinical Outcomes of Surgical Therapy trials [5,6], underwent left hemicolectomy. The numbers further diminish in the Australasian Laparoscopic Colon Cancer Study and Barcelona studies, with 22 (3.7%) and five (2.3%) participants, respectively [11,14]. Contrasted with right hemicolectomy or transverse colectomy, left hemicolectomy presents distinct anatomical and surgical complexities, especially when maneuvering the splenic flexure. Adding to this, the distinct embryonic origins, genetic properties, and biological actions segregate right and left colon cancers, leading to potential variations in survival outcomes [15–17]. Given these nuances, assessing the safety and efficacy of left and right colon cancer treatments warrants separate considerations. Yet, current clinical trials lack substantial representation of left hemicolectomy, highlighting a research imperative. Therefore, this study aimed to assess the safety and efficacy of LC versus open left hemicolectomy (OC) in patients with left-side colon cancer.

Patients and methods

Study design and setting

This research was performed at the Department of General Surgery, Menoufia University. Ethical Committee approval and written, informed consent were obtained from all patients. This study used a prospective, nonrandomized comparative design conducted at Menoufia University Hospital and Damanhur Medical National Institute from May 2020 to May 2022.

Participants

We enrolled 40 patients diagnosed with left-sided colonic carcinoma for this study. They were further categorized based on the type of surgical intervention they received: LC included 20 patients who underwent laparoscopic intervention for left-sided colonic carcinoma, and OC comprised 20 patients who underwent open surgical intervention for left-sided colonic carcinoma.

Inclusion and exclusion criteria

Patients aged between 18 and 80 years, from both sexes, who had a definitive diagnosis of left-sided colonic carcinoma, were eligible for inclusion. The cohort only comprised operable colonic carcinoma patients who demonstrated consistent postoperative follow-up and cooperation. Patients with multicentric colonic carcinoma deemed inoperable, those unavailable during the study, those who discovered metastasis intraoperatively, patients with operable liver metastasis, rectal cancer patients, those with contraindications for laparoscopy, and several other conditions were excluded.

Interventions

All participants underwent standard preoperative preparations. This involved various laboratory investigations, confirmation of left colon cancer diagnosis by colonoscopy and histopathological biopsy, and radiographic imaging. Appropriate bowel preparation, antibiotic prophylaxis, thrombosis prophylactic treatment, and a standardized enhanced recovery protocol were applied to all patients. The specific surgical techniques, equipment, and postoperative care protocols were strictly adhered to as per institutional standards.

Outcomes

The primary outcomes measured were operative time, blood loss, and incision length. Secondary outcomes included analgesic requirements assessed by the number of days intramuscular pentazocine was used, days to first flatus, days to start liquid intake, and length of postoperative hospital stay.

Statistical analysis

All collected data were statistically analyzed using IBM Corp. Released 2021. IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY: IBM Corp. Data were tested for normal distribution using the Shapiro–Wilk test. Quantitative data were represented as mean±SD, and qualitative data as frequencies and percentages. The independent t test, Mann–Whitney test, χ^2 test, and Fisher's exact test were employed where appropriate. A two-tailed P value less than or equal to 0.05 was deemed significant.

Ethical considerations

Official permission was acquired from the Faculty of Medicine, Menoufia University. The research received ethical approval from the ethical committee of the Faculty of Medicine, Menoufia University. The study strictly adhered to the World Medical Association (Declaration of Helsinki) guidelines for research involving human participants.

Results

Demographic characteristics

In a comparison between the LC and OC groups (Table 1), the mean age was 48.2±8.55 and 49.4

Table 1 Demographic and clinical characteristics

Variables	LC	OC	*P* value
Age (years)	48.2±8.55	49.4±8.36	0.656
BMI (kg/m^2)	28.65±1.24	28.59±1.2	0.867
MAP (mmHg)	94.7±5.89	95.7±5.48	0.581
Sex			
Male	10 (50)	12 (60)	0.525
Female	10 (50)	8 (40)	
Comorbidities			
DM	3 (15)	3 (15)	1.000
HTN	12 (60)	10 (50)	0.525
IHD	2 (10)	2 (10)	1.000
Smoking status			
Nonsmoker	14 (70)	13 (65)	0.736
Smoker	6 (30)	7 (35)	

Data are presented as *n* (%) unless otherwise mentioned. DM, diabetes mellitus; HTN, hypertension; IHD, ischemic heart disease; MAP, mean arterial pressure.

Table 2 Laboratory investigations of the studied groups

Parameters	LC	OC	*P* value
CBC			
Hb (g/dl)	12.45±0.9	12.48±0.98	0.920
WBCs (×10^3 cells/μl)	7.47±2.28	7.29±2.2	0.801
PLT (×103 cells/μl)	303.6±99.19	328.45±86.13	0.403
Kidney function tests			
Urea (mg/dl)	29.66±3.36	30.52±3.35	0.425
Creatinine (mg/dl)	0.88±0.3	0.96±0.31	0.358
Liver function tests			
AST (U/l)	24.96±7.18	25.04±5.78	0.971
ALT (U/l)	29.81±9.22	29.38±7.43	0.870
Total bilirubin (mg/dl)	0.68±0.2	0.66±0.19	0.747
Direct bilirubin (mg/dl)	0.24±0.17	0.21±0.14	0.490
Prothrombin time (s)	12.78±0.39	12.79±0.35	0.920
INR	1.1±0.09	1.1±0.08	0.902
Blood glucose tests			
FBG (mg/dl)	113±48.16	115.5±47.04	0.869
PPBG (mg/dl)	145.6±54.64	146.55±54.21	0.956
HbA1C (%)	6.39±1.413	6.39±1.41	1.000

Data are presented as mean±SD. ALT, alanine transaminase; AST, aspartate aminotransferase; CBC, complete blood count; FBG, fasting blood glucose; Hb, hemoglobin; HbA1C, glycated hemoglobin; INR, international normalized ratio; PLT, platelets; PPBG, postprandial blood glucose; WBCs, white blood cells.

±8.36 years, respectively (P=0.656). The average BMI was nearly identical at 28.65±1.24 kg/m^2 for the LC group and 28.59±1.2 kg/m^2 for the OC group (P=0.867). Mean arterial pressure values were 94.7 ±5.89 mmHg for the LC group and 95.7±5.48 mmHg for the OC group (P=0.581). Sex distribution showed that 50% were male and 50% were female in the LC group, whereas in the OC group, 60% were male and 40% were female (P=0.525). Comorbidity profiles indicated that 15% had diabetes mellitus, 60% had hypertension, and 10% had ischemic heart disease in the LC group, which mirrored the OC group with 15% having diabetes mellitus, 50% with hypertension, and 10% with ischemic heart disease, with no significant difference between the two groups (P>0.05). As for smoking status, 70% were nonsmokers and 30% were smokers in the LC group, compared with 65% nonsmokers and 35% smokers in the OC group (P=0.736).

Laboratory profile

In a comparative analysis of laboratory parameters between the LC and OC groups (Table 2), the complete blood count results were closely aligned. Hemoglobin levels were 12.45±0.9 g/dl for LC and 12.48±0.98 g/dl for OC (P=0.920). White blood cell counts were 7.47±2.28×10^3 cells/μl in the LC group compared with 7.29±2.2×10^3 cells/μl in the OC group (P=0.801). Platelets were measured at 303.6 ±99.19×10^3 cells/μl for LC and 328.45±86.13×10^3 cells/μl for OC (P=0.403).

For kidney function tests, urea levels were 29.66 ±3.36 mg/dl in the LC group versus 30.52±3.35 mg/dl in the OC group (P=0.425). Creatinine levels stood at 0.88±0.3 mg/dl for LC and 0.96±0.31 mg/dl for OC (P=0.358).

Liver function tests showed almost identical results between the two groups. Aspartate aminotransferase levels were 24.96±7.18 U/l in LC and 25.04±5.78 U/l in OC (P=0.971), while alanine transaminase was 29.81±9.22 U/l for LC versus 29.38±7.43 U/l for OC (P=0.870). Total bilirubin values were 0.68±0.2 mg/dl for LC and 0.66±0.19 mg/dl for OC (P=0.747), with direct bilirubin being 0.24±0.17 mg/dl for LC and 0.21 ±0.14 mg/dl for OC (P=0.490). Prothrombin time was nearly identical, measuring 12.78±0.39 s for LC and 12.79±0.35 s for OC (P=0.920). The international normalized ratio values were also similar at 1.1±0.09 for LC and 1.1±0.08 for OC (P=0.902).

Blood glucose tests indicated that fasting blood glucose was 113±48.16 mg/dl for LC and 115.5±47.04 mg/dl for OC (P=0.869). Postprandial blood glucose was 145.6±54.64 mg/dl in the LC group compared with 146.55±54.21 mg/dl in the OC group (P=0.956). Glycated hemoglobin percentages were exactly the same for both groups at 6.39±1.413% (P=1.000).

Intraoperative data

In the assessment of surgical outcomes between the LC and OC groups (Table 3), the need for blood transfusion was observed to be minimal, with 90% of the LC group having no need compared with

Table 3 Intraoperative data of the studied groups

Variables	LC	OC	*P* value
Blood transfusion needs			
No need	18 (90)	19 (95)	1.000
Two packed RBCs	2 (10)	1 (5)	
Splenic injury	1 (5)	0	1.000
Intestinal injury	1 (5)	0	1.000
Ureteric injury	0	1 (5)	1.000
Trocar site bleeding	0	0	–
Intraoperative mortality	0	0	–
Operative time (hours)	4.48±0.44	2.58±0.37	<0.001

Data are presented as *n* (%). RBCs, red blood cells.

95% in the OC group (*P*=1.000). In the LC group, 10% required two packed red blood cells, whereas this was observed in 5% of the OC group. Splenic injury and intestinal injury were noted in 5% of the LC group and were absent in the OC group, with both yielding a *P* value of 1.000. The ureteric injury was not observed in the LC group but was seen in 5% of the OC group (*P*=1.000). No incidents of trocar site bleeding or intraoperative mortality were reported in either group. On the other hand, the operative time was significantly shorter in the OC group compared with the LC (2.58±0.37 vs. 4.48±0.44 h, *P*<0.001), respectively.

Postoperative outcomes

In a comparative evaluation of postoperative outcomes between the LC and OC groups (Table 4), the incidence of pulmonary embolism was observed in 5% of the LC group and was absent in the OC group (*P*=1.000). Both groups reported no postoperative bleeding or leak. The abdominal collection was noted in 5% of both the LC and OC groups, with a *P* value of 1.000. Burst abdomen was not reported in the LC group but was observed in 10% of the OC group (*P*=0.487). Incisional hernia was seen in 5% of the LC group and 10% of the OC group (*P*=1.000). Intestinal fistula was absent in the LC group but was recorded in 10% of the OC group (*P*=0.487). A 5% requirement for ICU was noted in the LC group, whereas none was needed in the OC group (*P*=1.000). The time taken to resume a liquid diet was shorter in the LC group at 2.35±0.49 days compared with the OC group at 4.45±3.63 days, yielding a significant *P* value of 0.019. The time to pass the first flatus was also quicker in the LC group at 2.35±0.49 days compared with 3.45±0.69 days in the OC group (*P*<0.001). The length of hospital stay was significantly shorter for the LC group, averaging 4.1 ±0.31 days, in contrast to the OC group, which averaged 8.75±2.15 days (*P*<0.001). Furthermore, the number of lymph nodes harvested was higher in the LC group, with 13±1.08 compared with 11.85 ±0.75 in the OC group, indicating statistical significance with a *P* value of less than 0.001. Last, 30-day mortality was zero in both groups.

Table 4 Postoperative outcome of the studied groups

Variables	LC	OC	*P* value
Pulmonary embolism	1 (5)	0	1.000
Postoperative bleeding	0	0	–
Postoperative leak	0	0	–
Abdominal collection	1 (5)	1 (5)	1.000
Burst abdomen	0	2 (10)	0.487
Incisional hernia	1 (5)	2 (10)	1.000
Intestinal fistula	0	2 (10)	0.487
Need for ICU	1 (5)	0	1.000
Time to resume liquid diet (days)	2.35 ±0.49	4.45±3.63	0.019*
Time to pass first flatus (days)	2.35 ±0.49	3.45±0.69	<0.001*
Length of hospital stay (days)	4.1±0.31	8.75±2.15	<0.001*
Number of lymph nodes harvested	13±1.08	11.85 ±0.75	<0.001*
30-day mortality	0	0	–

*Statistically significant.

Discussion

The surgical intervention remains the primary CRC treatment, with the LC gaining prominence for its minimal invasiveness [18]. This technique, which involves a few small port site incisions, offers reduced postsurgical pain, quicker recovery, and a shortened hospitalization, facilitating patients' swift return to daily routines [19]. While recent findings indicate LC yields comparable oncological results to traditional surgeries, questions surrounding recurrence rates persist [20], highlighting the need for continued research into the comparative outcomes of these surgical approaches.

In this prospective study, analysis of intraoperative data showed no notable statistical difference between the groups concerning blood transfusion requirements or injuries to the spleen, intestine, or ureter. Importantly, no instances of trocar site bleeding or intraoperative deaths were recorded in either group. Similarly, Rabieh Mahmoud Mousa *et al.* [21] found no significant differences in intraoperative complications between their study cohorts. This congruence might stem from both studies focusing on the same ethnic demographic (Egyptian) and having a comparable patient sample size. On the other hand, a randomized trial included 627 patients who were randomly assigned to LC and 621 patients to OC. Blood loss during LC was significantly less than that during OC [7]. During LC, adhesions were more frequently classified as problematic than during OC [26 (5%) patients vs. 11 (2%) patients, *P*=0.02]. During surgery, 91 (17%) patients who were undergoing LC were converted to OC surgery [7]. These differences could be explained by their larger sample size and different types of resection (i.e. right hemicolectomy, left hemicolectomy, or sigmoidectomy). The blood supply to distal a third of the transverse colon, splenic flexure, descending colon, and upper sigmoid colon has been shown to vary between patients. Specifically, blood is carried by the inferior mesenteric artery through the left colic artery in 89% of cases and by the superior mesenteric artery through the middle colic artery in 11% of cases [22].

Our findings showed that OC surgery was associated with significantly lower operative time compared with laparoscopic. Similarly, Gavriilidis and Katsanos reported that LC means operative time was longer by 38 min, and surgery involving middle colic artery dissection at its origin necessarily requires surgeons with advanced LC expertise and specialized skills [23]. This kind of surgery is surgeon-dependent and learning curve-dependent and can extend the operative time. In agreement with our findings, Lezoche *et al.* [24] showed that the mean operative time for LC was significantly longer than the time for OC surgery (240 vs. 190 min), respectively. This finding was further confirmed by El-Shafei *et al.* [25] in the Egyptian cohort. On the other hand, Rabieh Mahmoud Mousa *et al.* [21] found no significant difference (*P*=0.10) between both techniques in terms of operative time. This could be explained by the variability and potential influence of surgeon expertise and learning curves on outcomes.

In evaluating postoperative outcomes, both study groups displayed similar rates for complications such as postoperative pulmonary embolism, abdominal collection, burst abdomen, incisional hernia, intestinal fistula, and ICU admissions. Remarkably, neither group experienced postoperative bleeding, leaks, or mortality within a month. Notably, those undergoing LC procedures exhibited a swifter return to consuming liquids (*P*=0.019) and had a quicker first flatus (*P*<0.001), resulting in a significantly reduced hospital stay (*P*<0.001). Reinforcing this, Huang *et al.* [26] conducted a retrospective analysis on 211 patients, revealing that the LC group had lesser blood loss and a more abbreviated hospitalization compared with the OC surgery group. Additionally, patients in the OC surgery group took significantly more time to achieve digestive milestones like bowel movement and liquid diet intake. A meta-analysis and systematic review encompassing 947 patients underscored these findings, showing quicker recovery timelines and a reduced hospital stay by an average of four-and-a-half days for LC over OC surgery [27]. Similarly, a randomized trial by Hasegawa *et al.* [28] with 59 CRC patients found that the LC group had a significantly faster recovery in terms of dietary intake and gas passage, as well as a reduced hospital stay.

Our findings contrast with the results from Rabieh Mahmoud Mousa *et al.* [19], they did not find a significant difference between the study groups concerning the count of affected lymph nodes. Yet, there was a marked difference in postoperative complications, with the LC group having none. Additionally, the length of hospital stay was notably shorter for the LC group compared with the OC surgery group (*P*=0.02) [19]. In a separate study, Chiu *et al.* [20] observed that while the average lymph node removal count was close between LC and OC methods, patients in the OC surgery group had higher rates of postoperative complications like urinary tract infections and wound infections. Various factors, including national patient demographics and differing follow-up durations, could account for these discrepancies.

LC, in the hands of proficient surgeons, has transformed to consistently offer effective, patient-focused, and cost-effective care for colorectal resections. Notably, this method has minimized complications when compared with traditional OC surgeries. To further enhance the efficacy and affordability of this procedure, emphasis should be placed on minimizing conversion rates and optimizing closure procedures at extraction and trocar sites, as echoed by Rabieh Mahmoud Mousa *et al.* [19], highlighting the benefits of shorter hospital stays and swift patient recovery. A detailed regression analysis pinpointed the surgical approach as a significant independent predictor for hospital stay duration, with LC patients showing a significantly shorter duration than their OC-surgery counterparts [29]. In a retrospective analysis by Guller *et al.* [30], it was found that, even after accounting for various factors, LC was linked to a reduced average hospital stay compared with OC surgical resection, 7.47 versus 9.37 days, respectively (*P*<0.001). However, contrasting studies have indicated that male patients face a heightened risk of complications in both OC and LC, particularly with increased rates of anastomotic leakage post-low rectal anastomoses [31,32].

We acknowledge that our study has some limitations, including the small sample size and the short duration of follow-up, which may hinder the generalizability of our findings. In addition, no data were obtained about the tumor stage. Finally, the radical resection and the oncological safety of the technique should be proven by long-term follow-up observation of chronic complications or recurrence rates.

In conclusion, the findings of this study demonstrate that LC and OC were comparable as regards intraoperative and postoperative complications. On the other hand, LC was considered a good and effective method for resection of left colonic carcinoma as it has many benefits, such as early recovery and short hospital stay.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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