Short-Term Outcomes of Laparoscopic-Assisted Colectomy versus Open Colectomy in Patients with Colonic Carcinoma: A Prospective Randomized Study

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Abstract

Introduction The second most common cause of cancer-related mortality is colorectal cancer, and laparoscopic-assisted colectomy (LAC) has gained popularity among surgeons as an alternative to the conventional approach, which is open colecrtomy (OC). The differences between LAC and OC in terms of short-term outcomes have not been well documented, and the aim of the present work is to compare the short-term outcomes of both procedures.

Materials and Methods The present prospective study comprised 164 participants submitted to LAC (n = 82) and OC (n = 82) at the Helwan and Zagazig University hospitals between January 2018 and January 2022. We collected and analyzed demographic data, surgical data, and the short-term outcomes.

Results The LAC group had a significantly lower estimated amount of blood loss, shorter hospital stay, lower rates of incisional surgical site infection, and fewer cases of burst abdomen postoperatively, but with a considerably longer operative time (30.3 minutes) than the OC group.

Conclusions Our findings show that LAC is favorable option to OC, with superior outcomes.

Keywords
- colon cancer
- laparoscopic-assisted colectomy
- open colectomy

Introduction

Colorectal cancer is the third most prevelant cancer in males and the second most common in females, and its prevelance has increased in recent years. It is the second most frequent cause of cancer-related mortality. Therefore, it is an international public health challenge in terms of morbidity, mortality, and use of health care services, including rising medical costs.[1]

The cornerstone of the curative treatment for colonic carcinoma is surgical excision of the primary tumour.[2] Throughout the last century, open colectomy (OC) was the primary treatment for colonic carcinoma. Since the first reports of laparoscopic-assisted colectomy (LAC), published

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in 1991, and with the advancement and widespread application of medical technology, LAC has gained popularity among surgeons worldwide over the past 30 years.[3]

With oncological long-term outcomes comparable to those of the conventional surgery, LAC is now broadly used by surgeons around the world with several advantages, such as lower amount of blood loss, shorter wound incision, and a quicker recovery of intestinal function.[4]

Numerous studies[5] have demonstrated that LAC can be performed with outcomes that are equivalent to those of OC, but the differences between the two procedures in terms of short-term outcomes and postoperative complications, particularly outside of specialized centers, have not been well described nor thoroughly documented.

The objective of the present study is to compare the short-term outcomes of LAC and OC in different parts of the colon in patients with colonic carcinoma.

Patients and Methods

We conducted a prospective study comprising 164 patients admitted to the Helwan and Zagazig University hospitals between January 2018 and January 2022. All patients provided written informed consent, and the Research Ethical Committee approved the work. The study was performed in conformity with the Declaration of Helsinki, which is the World Medical Association's code of ethics for studies involving humans. A computer was used to create a sequence for allocation. The treatment assignments of the participants were then placed in opaque, serially-numbered envelopes. After a patient was enrolled, the next envelope in the sequence was opened, revealing the treatment. This method met the criteria for unpredictability and concealment. The participants were divided into two groups according to the type of procedure.

Laparoscopy group (LG): 82 patients who underwent LAC for colonic carcinoma.

Open group (OG): 82 patients who underwent OC for colonic carcinoma.

Inclusion Criteria

The inclusion criteria were male and female patients aged 18 years and more with a diagnosis of operable colonic carcinoma, fit for laparoscoy, and willing to participate in the study.

Exclusion Criteria

We excluded patients with inoperable, multicentric, recurring colonic cancer, those with intraoperative complications that mandated conversion to OC, patients with contraindication to laparoscopy, and those who were unable to participate or unavailable during the conduction of the study.

Preoperative Preparation

Laboratory parameters such as the levels of CBC, PT, PTT, INR, and the CEA tumor marker, liver and kidney function tests, random blood glucose level, and the Hepatitis C Virus and Hepatitis B Virus viral markers were used to evaluate the patients prior to surgery. Additionally, participants underwent a colonoscopy with biopsy for histopathology, as well as chest, abdomen, and pelvis contrast-enhanced computed tomography scans. The participants provided consented for the performance of the surgery. Bowel preparation was performed, and the urinary catheter and nasogastric tube were inserted. Antibiotics were administered during the induction phase of anesthesia. Sequential compression stockings were used, and low-molecular-weight heparin anticoagulant was administered subcutaneously for deep venous thrombosis prophylaxis.

Open Colectomy

With the participants in the supine position, general anesthesia with endotracheal intubation was induced; then, the midline exploratory incision was performed until the peritoneum. An evaluation of the liver and peritoneum was performed to rule out any metastases or signs of inoperability, followed by detection of the tumor site with with site-specific resection and anastomosis, abdominal lavage, and layer-by-layer abdominal incision closure with intra-abdominal tube drains. The intra- and postoperative complications were recorded, and the amount of blood loss was estimated using a soaked gauze, with each piece absorbing 150 mL of blood (►**Fig. 1(b)**).

Laparoscopic-Assisted Colectomy

Following the induction of general anaesthesia and endotracheal intubation, the subject was positioned appropriately regarding the operated site. Pneumoperitoneum was induced via a 10-mm subumbilical safety trocar. According to the location of the tumor, trocars are positioned. Prior to beginning the procedure, the entire abdomen was assessed to rule out any liver or intraperitoneal metastases. We applied the medial-to lateral technique, which requires ligation of the lymphovascular bundle first followed by resection of the colon from its peritoneal attachments. Then hemostasis was completed and extracorporeal functional end-to-end anastomosis was performed through a small laparotomy (►**Fig. 1(a)**). Irrigation and suction lavage of the peritoneal space and port site were performed, intraperitoneal tube drains were inserted, and the trocars were removed through deflation of Co2. The port sites were closed, and the intra- and postoperative complications were recorded.

Postoperative Care

The same group of surgeons managed the postoperative care of all participants. Intravenous antibiotics and fluids were continued postoperatiely and, after the verification of the recovery of the intestinal peristalsis, liquefied diet was started. A semiliquid diet was prescribed after the passage of flatus, and it progressed to a regular diet as the patient tolerated oral nourishment. Early ambulation is initiated to avoid deep vein thrombosis (Deep Venous Thrombosis), and the urinary catheter was removed as early as possible. Daily accessibility to the patients' wounds as needed for dressing. The patients were examined twice a week for the first month

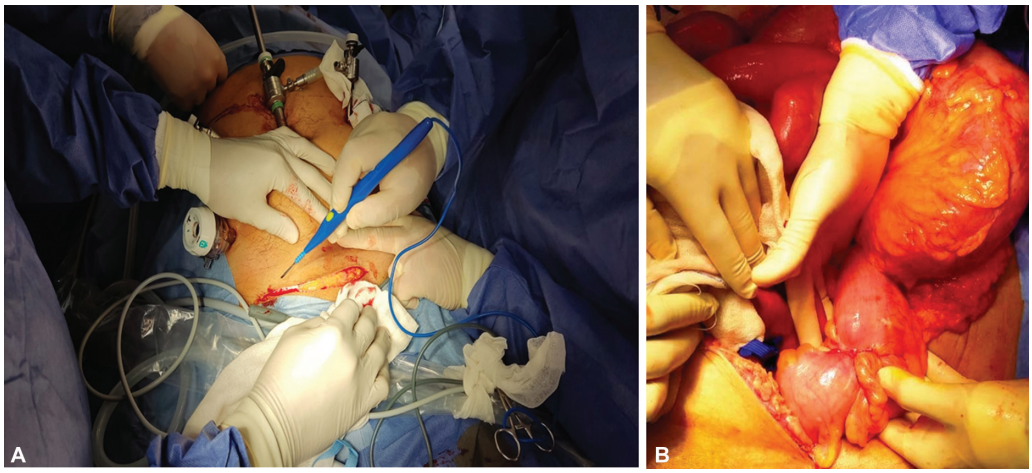

Fig. 1 Surgical techniques: (A) small incision in the LAC procedure; (b) OC.

and then every month for the first six months. Subsequently, patients were requested to connect us if they had any complications.

Results

Patient Demographics

The present prospective study was conducted with 164 patients with colonic carcinoma (82 patients operated by OC and 82, by LAC) admitted to the outpatient clinics of the Helwan and Zagazig University hospitals between January 2018 and January 2022. There were no significant differences in terms of gender, age, and body mass index (BMI) between the groups (►**Table 1**).

Number of Affected Lymph Nodes

Regarding the number of affected lymph nodes, there was no statistically significant difference between the study groups.

Table 1 Comparison of the demographic data and perioperative variables of both study groups

Characteristics	Total (n = 164)	OG (n = 82)	LC (n = 82)	*p*-value
Mean age in years: mean (SD)	56.9 (±9.8)	57.7 (±10.62)	56.06 (±8.98)	0.271
Gender: male/female – n (%)	87/77 (53/47)	43/39 (52.4/47.6)	44/38 (53.7/46.3)	0.876
Mean BMI in Kg/m^2: mean (SD)	27.94 (±3.6)	28.29 (±3.69)	27.59 (±3.54)	0.213
Intraoperative complications (according to the CTCAE version 5.0): n (%)				
Grade 3	4 (2.4)	3 (3.6)	1 (1.2)	0.62
Grade 4	0	0	0	
Grade 5	0	0	0	
Mean blood loss in mL: mean (SD)	329.2 (±155)	402.6 (±147.7)	255.7 (±125)	< 0.001
Harvested LNs: n (%)				
< 12	33 (20.1)	18 (22)	15 (18.3)	0.559
> 12	131 (79.9)	64 (78)	67 (81.7)	
Mean operative time in minutes: mean (SD)	141.8 (±30.1)	126.7 (±24.9)	157 (±27.2)	< 0.001
Postoperative complications: n (%)				
Leakage	7 (4.3)	4 (4.9)	3 (3.7)	0.7
Organ-space SSI	16 (9.8)	10 (12.2)	6 (7.3)	0.292
Incisional SSI	11 (6.7)	10 (12.2)	1 (1.2)	0.013
Burst abdomen	7 (4.3)	7 (8.5)	0	0.007
Chest infection	14 (8.5)	9 (11)	5 (6.1)	0.402
Hospital stay in days: mean (SD)	8 (±5.1)	11.2 (±5.2)	4.8 (±2.3)	< 0.001

Abbreviations: BMI, Body Mass Index; CTCAE, Common Terminology Criteria for Adverse Events; LAC, laparoscopic-assisted colectomy; LN, lymph node; OC, open colectomy; SD, standard deviation; SSI, surgical site infection.

Intraoperative Complications

The rate of complications was determined through the Common Terminology Criteria for Adverse Events (CTCAE), version 5.0.[6] Grade-3 injuries were presented by 1 patient (1.2%) in the LG, and by 3 (3.6%) patients in the OG, with no statistically significant differences between the groups.

Postoperative Complications

Postoperative complications were observed in 15(18.3%) patients in the LG and in 40(48.8%) patients in the OG. Regarding incisional SSI and burst abdomen postoperative complications, there was a statistically significant difference between the groups ($p < 0.05$), but no statistically significant differences were observed regarding leak, organ-space SSI, or chest infection.

Operation Time

In the LG, the mean operative time was of 157 (range: 110 to 210) minutes, while in the OG it was of 126.7 (range: 90 to 190) minutes, which was statistically significant ($p < 0.01$).

Length of Hospital Stay

The mean length of hospital stay was of 4.8 (range: 2 to 16) days in the LG and of 11.2 (range: 4 to 27) days, which was also statistically significant ($p \leq 0.01$).

Amount of Blood Loss

The mean amount of blood loss was of 255.7 (range: 100 to 650) mL in the LG, and of 402.6 (range: 150 to 850) mL, which eas statistically significant ($p \leq 0.01$) (►**Fig. 2**).

Discussion

Curative surgical resection is the backbone of the treatment for colonic carcinoma.[7]

Since the first description of LAC procedure, numerous studies[1–12] have demonstrated that, as compared to OC, LAC resections are associated with lower levels of pain, quicker recovery, and non-inferior oncological results. Although laparoscopic colorectal surgery has grown in popularity in recent years, numerous international surveys[13–19] have revealed that it is still mostly underutilised, with significant variations among centres.[8] The present study highlights the use of of LAC techniques in the resection of colon cancer and the difference between them ond OC techniques in patients admitted to the Helwan and Zagazig university hospitals.

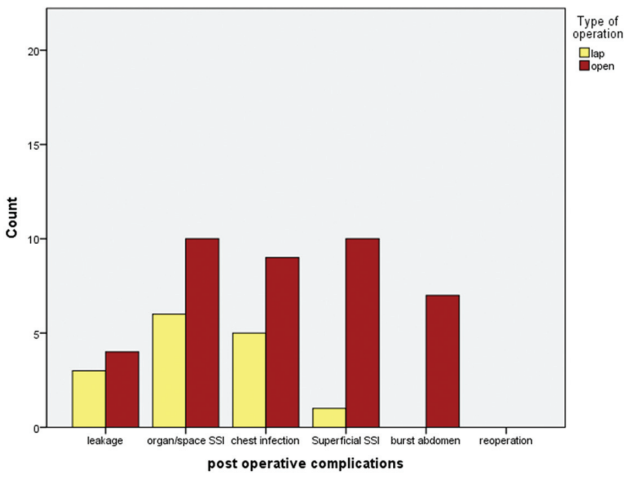

Fig. 2 Comparison between the LG and OG regarding postoperative complications.

In the present work, we assessed the efficacy of LAC in attaining the proper resection of the lymph nodes (LNs) affected in the vascular pedicle of the colon. We did not observe statistically significant differences between the groups concerning the number of LNs affected, which is in line with the study by Cheong et al.[9] reported that in colonic cancer resections the LN harvested did not vary greatly between different operative approaches for each of the operations either LAC or OC, which is in line with the study by Balducci et al.[10] However, Douaiher et al.[11] reported that laparoscopic colonic resections were 1.5 to 2.5 times more likely to attain adequate LN resection compared to OC whoever several non-modifiable patient and tumer related factors may render adequate LN harvested challenging also. Ringressi et al. highighted that the oncological effectiveness of LAC compared with OG as assesed by the same number of retrieved/examined LNs in the two study groups. Anania et al.[13] reported that laparoscopic resection may enable the harvest of more LNs than OG.

In the present study, as well as in the study by Ali et al.,[14] the amount of blood loss was lower in the LG than in the OG, with a high statistically significant difference. Anania et al.[13] repoted that laparoscopic resection resulted in lower levels of estimated blood loss.

In the present study, the rate of postoperative anastomotic leakage (AL) was of 4.9% (4/82 cases) in the OG, and of 3.7% (3/82 cases) in the LG, which is in agreement with the study by Chiarello et al.[15] Mousa et al.[16] found rates of postoperative AL of about 13.3% in the OG, with no cases in the LG. However, the articles in the literature[30,31] on the effect of laparoscopy on AL report varying rates. There has been some concern that laparoscopic resection may be associated with increased rates of AL; however, most series[32,33] show no significant difference.

In the present study, the rates of incisional SSI (wound infection) and burst abdomen were significantly lower in the LG than in the OG, while the rates of organ-space SSI (intraperitoneal infection) and chest infection were not significant, which is in agreement with the study by Farooq et al.,[17] who reported that the LG had a much shorter length of hospital stay, a lower risk of SSI, as well as a lower risk of developing postoperative incisional hernia defect. Moreover, Caroff et al.[18] stated that laparoscopy results in a lower SSI rate than OC in healthy patients as well as in those with several comorbidities. Tateno et al.[19] reported that laproscopic resection for colonic carcinoma can be performed safely and successfully in former COVID-19 patients who had been asymptomatic three weeks before the operation. Also, Leraas et al.[20] noticed that the overall rate of complications was lower in patients submitted to laparoscopic resections, specially wound complications, urinary tract infection,

venous thromboembolic complications, respiratory complications, AL, postoperative ileus, need of blood transfusion, and septic complications.

In the present study, the mean operative time in the LG was longer by 30.3 minutes, which is in line with the study by Gavriilidis,[21] who reported that the mean operative time in the LG was longer by 38 minutes. Since laparoscopic colonic resection must be performed by professionals as laparoscopic colonic resection requires operators with advanced experience in laparoscopy and specialized familiarity as this kind of operations depends on the surgeon skills and the learning curve and these factors can increase the operative time. Feo et al.[22] have also reported tha the LG had a longer operative time than the OG, and Huang et al. [23] observed that the LG was associated with prolonged operative time, while Popek et al.[24] found similar operative times regarding both procedures.

As for the length of hospital stay, in the present study it was shorter in the LG, which is in line with the study by Farooq et al.[17] Schootman et al.[25] found a shorter hospital stay and better overall outcomes in the LG.

According to Curet et al.,[26] LAC for colonic carcinoma can be performed successfully with morbidity and mortality rates comparable to those of OC. Farooq et al.[17] reported that the disadvantages include the need for additional technical skills and the limited field of vision, which make complicated surgeries challenging and lengthen the operative times. However, the benefits provided are enormous. Tamagawa et al.[27] concluded that LAC is oncologically safe and results in better short-term outcomes in comparison to OC. Abu El-Haggag et al.[28] reported that laparoscopic colectomy is a safe, valid, and feasible technique, as it is associated with shorter incisions, lower levels of blood loss, rapid recovery after surgery, and shorter postoperative hospital stay compared with the conventional open technique.

The gold standard of care for the treatment of patients with non-advanced colonic carcinoma, according to Ringressi 2021 et al.,[12] is minimally-invasive resections. Huang et al.[23] found that laparoscopy was associated with enhanced perioperative events and reduced risk of adverse outcomes, and the long-term survival in their study was comparable to that achieved through OC. Moreover, Yamauchi et al.[29] demonstrated the non-inferiority of laparoscopy compared to OC, and they observed no differences in technical and oncological safety.

Farooq et al.[17] reported that laparoscopic colonic resection is associated with shorter hospital stays, lower levels of blood loss, small incisions, a lower risk of SSI, as well as a lower risk postoperative incisional hernia defect. Therefore, where available, LAC should be highly encouraged, for it will greatly decrease the already high morbidity of patients with colonic carcinoma, and yield improved outcomes than those of open surgery.

Conclusion

The performance of LAC in cases of colonic carcinoma has been found to be a more favorable surgical option than OC, with better outcomes such as lowerlevels of blood loss, lower rate of postoperative complications, shorter length of hospital stay, and good oncological control.

Authors' Contributions

The clinical procedures were performed by YB, ME and YO, who were also involved in the writing of the paper or critical revision. YB and YO participated in patient recruitment and contributed to to data collection. The analysis and interpretation of the data were performed with the help of YB and ME. The final manuscript was read and approved by all authors.

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Conflict of Interests

The authors have no conflict of interests to declare.

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