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Laparoscopic versus open complete meso-colic excision for right-sided colon cancer. Analysis of short-term outcomes

AIM: *Laparoscopic complete mesocolic excision (CME) right hemicolectomy would show comparable short-term benefits as well as pathological and oncological outcomes to open surgery. The aim of this study was to compare laparoscopic and open CME technique for right-sided colon cancers in terms of pathology specimens and short-term results.*
MATERIAL AND METODS: *The data of patients who underwent laparoscopic CME (n=31) and open CME (n=35) for right-sided colon adenocarcinoma between January 2016 and June 2019 were analyzed retrospectively. Demographic data, preoperative, peroperative and postoperative parameters and pathology specimens of the two groups were compared.*
RESULTS: *There were no statistical differences between the laparoscopic CME group and the open CME group in terms of age, gender, body mass index, tumor location, American Society of Anesthesiologists (ASA) score, presence of comorbidities, history of other malignancy and previous abdominal surgery (p>0.05). Patients in the laparoscopic CME group had shorter incision lengths, longer operative times, less operative blood loss, shorter time to mobilization, early regain of bowel motion, shorter time to soft diet, reduced length of stay, and smaller tumor size (p<0.05). The mean number of harvested lymph nodes in laparoscopic and open CME groups was not statistically significant (29.83 ± 8.90 and 31.34 ± 13.10, respectively). There were no statistical differences in terms of length of the specimen between the laparoscopic and open CME groups (35.19 ± 9.8 cm and 32.71 ± 11.12 cm, respectively). The rate of 30-day postoperative complications was higher in the open CME group (35.5% vs. 42.9%, respectively), but not statistically significant (p>0.05).*
CONCLUSIONS: *Pathological (specimen lengths, resection margin lengths, number of lymph nodes, and R0 resection) and short-term outcomes of the laparoscopic CME group were comparable. Moreover, laparoscopic CME conferred short-term benefits in terms of shorter incision lengths, less operative blood loss, reduced time to mobilization, early regain of bowel motion, shorter time to soft diet, and reduced length of hospital stay. Based on these results, laparoscopic CME can be considered as a routine elective approach for right-sided colon cancer.*

KEY WORDS: Colon cancer, Complete mesocolic excision, Right hemicolectomy

Introduction

Colorectal cancer is the fourth most frequently diagnosed cancers and the second leading cause of cancer death in the world [1]. In practice, conventional colon cancer surgery includes en bloc resection of the involved colonic segment with its lymph node containing mesentery and ligation of draining vessels. Recently, Hohenberger *et al*. published an article on complete mesocolic excision (CME) associated with central vascular ligation (CVL) for colon cancer in 2009 [2]. The CME technique is basically to continue dissection along embryological plans to obtain a clean peripheral surgical margin, and to separate the major arteries and veins from their origin after extensive colon mobilization [2-4]. CME is con-

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sistent with the principles of total mesorectal excision (TME) and have good surgical and oncological outcomes [5]. Although the degree of surgery between CME and D3 dissection is not the same, Hohenberger's principles are preserved in D3 lymphadenectomy in the Japanese experience [6-9]. Japanese D3 lymphadenectomy for colon cancer is a surgical procedure commonly used in Far Eastern countries [5].

The oncological safety of the laparoscopic method for colon cancer has been proven in randomized clinical trials [10-12]. Guerrieri *et al.* reported that laparoscopic colectomy for cancer is feasible, safe and not encumbered by an higher complications rate compared to open colectomy in their series of more than three hundred cases [13]. Laparoscopic approach provides clear short-term beneficial results such as less blood loss during surgery, less pain after surgery, early return of bowel functions, early intake of oral food, and shorter hospital stay [14-16]. Feng et al. reported the first study of laparoscopic CME in 64 patients with right colon cancer in 2012 [17]. There is still controversy as to whether the positive oncological outcomes of open CME can be reproduced by laparoscopic CME [18,19]. To date, several comparative studies evaluating the feasibility and safety of laparoscopic CME for right-sided colon cancer have been published [18,20-24]. The aim of this study was to compare laparoscopic and open CME technique for right-sided colon cancer in terms of pathology specimens and short-term results.

Material and Methods

This study was performed retrospectively in a single center. Data of 66 patients who underwent open or laparoscopic CME for right-sided colon adenocarcinoma between January 2016 and May 2019 in our clinic were analyzed. All patients underwent preoperatively routine laboratory tests, tumor markers, total colonoscopy and biopsy. Abdomino-pelvic computed tomography (CT) was performed for preoperative staging. Patients with extensive locoregional spread and distant metastasis (stage 4) were not included in the study. Patients who underwent emergency surgery, patients undergoing multiple organ resection, patients with intestinal obstruction or perforation, concurrent multiple or metachronous colon cancer and patients with hereditary colon cancer (familial adenomatous polyposis or hereditary non-polyposis colorectal cancer) were excluded from the study. The informed consent was read and signed by all participants. This study was approved by the Institutional Review Board of our institute (IRB No. 14.06.2019/89/3). All procedures performed in this study involving human participant were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards (Table I).

Surgical Techniques

During colon cancer surgery, we strictly adhered to the principle of preservation of the intact visceral layer and the high ligation of the feeding vessels. After preoperative preparation, CME with CVL were performed in patients with right-sided colon cancer.

Laparoscopic Surgery

Each patient was placed on the operating table in Trendelenburg and slightly left lateral position. The assistant was on the right, the operator and the cameraman were on the left of the patient. Pneumoperitoneum was provided with a 10 mm port placed under the umbilicus. This port was also used as the camera port. A total of 3 ports were placed on the abdomen, 5 mm on the right lower, 5 mm on the left lower and 10 mm on the left upper. The trocar on the right side was used by the assistant and the trocars on the left side were used as operating ports.

Firstly, an abdominal exploration was performed. The right colon was suspended upward, and a medial to late-

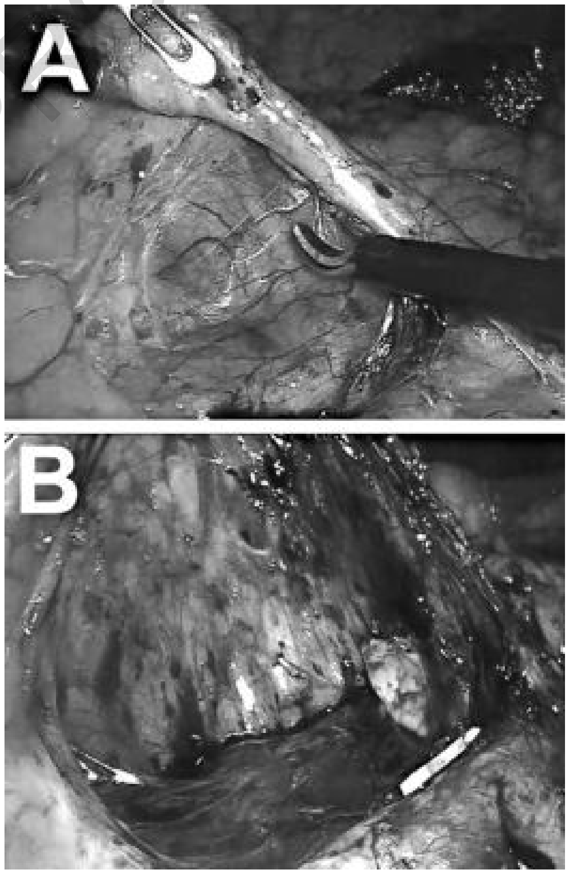

Fig. 1: Pulling upward the right colon, along with the ileocolic mesentery, and entering the retroperitoneum under the ileocolic mesentery (A), and full mobilization of the right mesocolon (B).

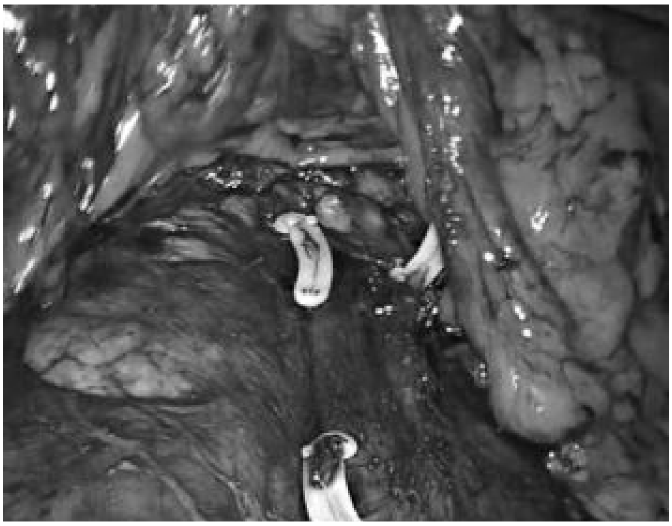

Fig. 2: Transection of the branches of the superior mesenteric artery and vein from their roots.

ral dissection was done in all cases. After the superior mesenteric vein (SMV) and ileocolic vessels were identified, an incision was made approximately 2 cm below the ileocolic vessels, and mobilization of the terminal ileum and right colon was performed along embryological plans. The dissection plan between the mesocolon and the Gerota's fascia was continued until the duodenum and the head of the pancreas were fully exposed (Fig. 1 A and B). Dissection was continued along the anterior side of the SMV, and the ileocolic artery and vein were ligated at the root of the superior mesenteric vessels. The right colic vessels, if present, were identified and ligated at the root. The lymphadenectomy of the anterior aspect of the SMV was performed in such a way that it was en bloc from the ileocolic vessels to the gastrocolic trunc of Henle (Fig. 2). The middle colic vessels were ligated at the root of the superior mesenteric vessels for the hepatic flexura and transverse colon tumors. However, for the cecum and ascending colon tumors, the right branches of the middle colic vessels were ligated at the root. Omentectomy was performed just below the gastroepiploic vessels and the right gastroepiploic vessels were preserved unless infiltrated by the tumor. The right colon was completely released (Fig. 3 A and B). The umbilical port incision was enlarged by an average of 5 cm and the released colon was removed using a wound protector (Fig. 4). Resection was performed with a clean surgical margin and anastomosis was performed side-to-side with stapler. A drain was placed in the abdomen.

Open Surgery

Patients in this group were placed on the operating table in a supine position and a midline incision was made.

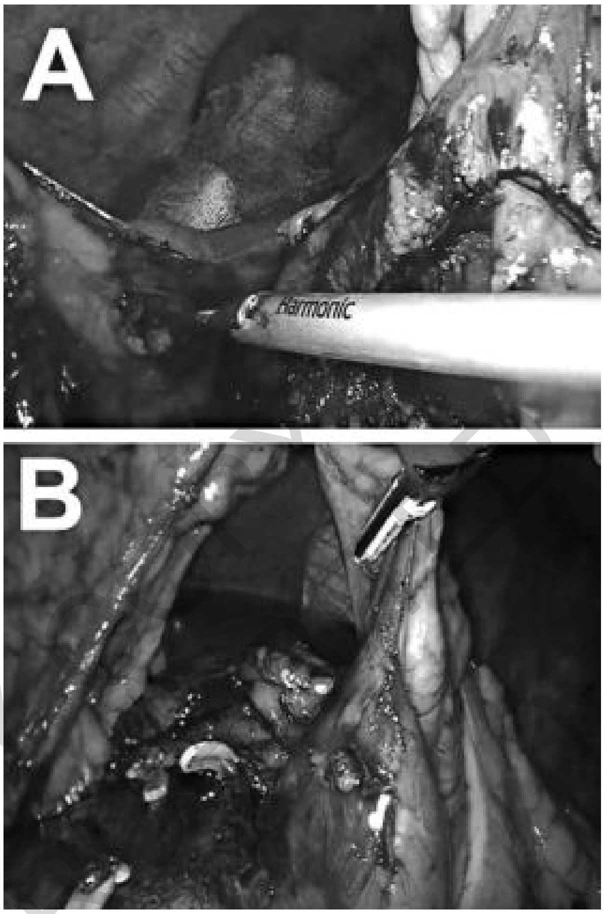

Fig. 3: Separation of the right colon from the lateral ligaments (A) and complete releasing the right colon (B).

The right colon was mobilized in the paracolic groove through the avascular plane of Toldt. Right ureter, gonadal vessels and duodenum were protected. The ascending colon and hepatic flexure were mobilized over the duodenum and Gerota's fascia. Ligation of ileocolic vessels, right colic vessels and right branches of middle colic vessels were performed in cecum and ascending colon tumors. In hepatic flexura and transverse colon tumors, ligation was performed from the origins of ileocolic vessels, right colic vessels, and middle colic vessels. After the right colon was fully mobilized, the terminal ileum and transverse colon were transected. Then, an ileocolic anastomosis was performed side-to-side with stapler. Then, the mesocolic defect was closed, a drain was placed close to the anastomosis, and the abdomen was closed.

Data Collection

Events requiring additional treatment within 30 days after surgery were defined as postoperative morbidity and graded according to the Clavien-Dindo classification [25]. Data of the patients were recorded and stored prospec-

Fig. 4: Removal of the freed colon through the abdominal mini-incision made on the umbilicus by using a wound protector.

tively. Pathological evaluation was performed according to the 7th edition of the American Joint Cancer Committee (AJCC). Demographic data, intraoperative and postoperative parameters and histopathological results of both groups were compared.

STATISTICAL ANALYSIS

Statistical analysis was carried out using IBM SPSS Statistics ver. 24.0 (IBM Co., Armonk, NY, USA). Continuous data were presented as mean (standard deviation) or median (range), and categorical data as frequency. Student's *t*-test was used for comparison of continuous variables and Chi-square test was used for comparison of categorical variables. Based on the results of analyses, the p value < 0.05 was considered to be statistically significant.

Results

Patients' basic characteristics are presented in Table I. The laparoscopic surgery group consisted of 31 patients (15 males and 16 females) with an average age of 60.5±13.57 years, and the open surgery group consisted of 35 patients (18 males and 17 females) with a mean age of 60.22±13.5 years. There were no statistical differences between open and laparoscopic CME groups in

TABLE I - *Patients' characteristics.*

Data		CME (n=31)	Open CME (n=35)	p value
Age (SD)		60.5+13.5	60.2+13.05	0.931
	Age 70	7 (22.6%)	8 (22.9%)	0.979
Gender				
	Female	16 (51.6%)	17 (48.6%)	0.805
	Male	15 (48.4%)	18 (51.4%)	
BMI (SD)		25.6+4.50	26.1+4.06	0.636
	BMI 30	6 (19.4%)	8 (22.9%)	
Tumor location				
	Cecum	5 (16%)	13 (37%)	0.106
	Ascending colon	14 (45.2%)	15 (42.9%)	
	Hepatic flexure	7 (22.6%)	6 (17.1%)	
	Transverse colon	5 (16.1%)	1 (2.9%)	
ASA class				0.088
	ASA 1	9 (29%)	18 (51.4%)	
	ASA 2	18 (58.1%)	11 (31.4%)	
	ASA 3	4 (12.9%)	6 (17.1%)	
Presence of comorbidities				
	No	18 (58.1%)	19 (54.3%)	0.758
	Yes	13 (41.9%)	16 (45.7%)	
History of other malignancy				
	No	28 (90.3%)	31 (88.6%)	0.818
	Yes	3 (9.7%)	4 (11.4%)	
Previous abdominal surgery				
	No	22 (71%)	28 (35%)	0.393
	Yes	9 (29%)	7 (20%)	

Legend: SD: Standard Deviation; BMI: Body Mass Index

TABLE II - *Data of surgical procedure.*

Data	Laparoscopic CME (n=31)	Open CME(n=35)	p value
Length of incision (SD) (mm)	76.54+38.5	185.57+20.8	0.001
Surgery time (SD) (range) (minutes)	165.48+28.2(120-240)	140.8+18.0(120-200)	0.001
Blood loss (SD) (range) (mL)	44.8+34.2(15-200)	88.1+58.4(25-280)	0.001
Conversion to open surgery (n), (%)	1 (3.2%)		

Legend: SD: Standard Deviation

terms of age, gender, body mass index (BMI), tumor location, American Society of Anesthesiologists (ASA) score, presence of comorbidities, history of other malignancy and previous abdominal surgery.

Surgical results are presented as shown in Table II. This study showed that there was a statistically significant difference between laparoscopic and open CME groups compared to the length of the incision, since the incision of the open technique (185.5±20 mm) was longer than the incision of the laparoscopic technique (76.5±38 mm) (p <0.001). In addition, there was a statistically significant difference between the two procedures related to the operative time because the laparoscopic technique (140.8±18 min; range: 120 - 240 min) took more time than the open technique (165.48±28.2 min; range: 120-200 min) (p<0.001). Intraoperative blood loss during laparoscopic technique was less than open technique (15-200 mL and 25-280 mL, respectively) (p<0.001). In the laparoscopic group, there was a case that was converted to open right hemicolectomy with CME due to technical reasons.

Histopathological findings are shown in Table III. Tumor size was greater in the open CME group (4.62±1.74 cm) than in the laparoscopic CME group (6.58±2.7 cm) (p=0.003). There was no difference between open and laparoscopic CME groups in terms of pT category, pN category, pTNM, R0 resection rate, histologic grade, lymphatic invasion, venous invasion, and perineural invasion.

There was no statistically significant difference in terms of specimen length between laparoscopic and open CME groups (35.19±9.8 cm *vs*. 32.71±11.12 cm, respectively). Moreover, proximal and distal margins were similar between the two groups. There was no statistically significant difference in terms of the mean number of harvested lymph nodes (29.83±8.90 *vs*. 31.34±13.10, respectively) and the mean number of metastatic lymph nodes (1.32±1.8 *vs*. 2.08±3.9, respectively) between laparoscopic and open CME groups.

Postoperative data of the patients is given in Table IV. The recovery of bowel function was within 2.32±0.79 days in the laparoscopic CME group and 2.8±0.75 days in the open CME group (p=0.015). Moreover, time to fluid diet and hospital stay were significantly shorter in laparoscopic CME group than open CME group (p<0.05). There was no statistically significant difference in terms of Clavien-Dindo grades and complications such as ileus, anastomotic leakage, wound infection, respiratory complications, wound dehiscence and re-operation during the first 30 days (p> 0.05). There was no mortality in the first 30 days postoperatively.

Discussion

There is a global consensus that TME is the standard for rectal cancer surgery. The procedure is based on intact en bloc resection of mesorectum, tumor and lymphatic drainage [17,26]. Since the concept of TME was first proposed by Heald *et al*. in 1982 [27], it has become a standardized surgical procedure for middle and low rectal cancers. It is effective in decreasing the local recurrence rate and prolonging cancer-related survival [28,29].

Hohenberger *et al*. applied the TME concept to colon cancer surgery, and described CVL together with CME [2]. Studies have shown that, in open colon cancer surgery, CVL with CME improves local disease control and improves overall survival [2,3]. In our study, laparoscopic and open full mesocolic excision and feasibility of CVL were compared in terms of technical feasibility and positive and negative effects of both techniques. The CME technique involves two main strategies; sharp dissection of visceral and parietal fascia, ligation from the root of the main feeding vessels and more radical lymph node dissection to improve oncologic outcomes [20]. This technique results in a larger bowel resection, CME, and multiple lymph node excision [3,4,30].

Although right hemicolectomy is now routinely performed, the applicability and safety of CME in open surgery has recently been demonstrated in a small number of centers [22,31,32]. Nowadays, laparoscopic colectomy has become a standard surgical treatment for colon cancer because of its short-term benefits, such as oncologic outcomes compared to open colectomy [20,21,26,33]. With the emergence of CME, laparoscopic CME has been reported increasingly in colectomy and encouraging results have been accumulating. Although laparoscopic surgery is now accepted as the standard treatment for right-sided colon cancer resection, laparoscopic CME right hemicolectomy is considered a difficult procedure [20,34-36].

TABLE III - *Data of histopathological examination.*

Data		Laparoscopic CME (n=31)	Open CME (n=35)	p value
Length of specimen (SD)		35.19+9.8	32.71+11.12	0.343
Length of proximal margin (SD)		14.79+7.85	13.51+5.77	0.451
Length of distal margin (SD)		17.19+8.94	15.85+10.16	0.575
Residuel tumor [radial margin (+)]		0	1 (2.9%)	0.343
Tumor size (SD)		4.62+1.74	6.58+2.7	0.003
Number of retrieved lymph nodes (SD) (median/range)		29.83+8.90(30/15-47)	31.34+13.10(30/16-75)	0.592
Number of metastatic lymph nodes (SD) (range)		1.32+1.8(0-7)	2.08+3.9(0-17)	0.973
Tumor grade				
	High	6 (19.4%)	12 (34.3%)	0.342
	Moderate	10 (32.3%)	11 (31.4%)	
	Low	15 (48.4%)	12 (34.3%)	
Depth of invasion (T)				
	T1	1 (3.2%)	2 (5.7%)	0.107
	T2	2 (6.5%)	3 (8.6%)	
	T3	7 (22.6%)	1 (2.9%)	
	T4	21 (67%)	29 (82.9%)	
Nodal involvement (N)				
	N0	14 (45.2%)	16 (45.7%)	0.711
	N1	13 (25.8%)	13 (37.2%)	
	N2	4 (12.9%)	6 (17.2%)	
Neural invasion		21 (67.7%)	30 (85.7%)	0.082
Lymphatic invasion		25 (80.6%)	33 (94.3%)	0.094
Venous invasion		25 (80.6%)	32 (91.4%)	0.180
TNM stage				
	Stage 1	3 (9.7%)	1 (2.9%)	0.288
	Stage 2	11 (35.5%)	18 (51.4%)	
	Stage 3	17 (54.8%)	16 (45.7%)	

Legend: SD: Standard Deviation

TABLE IV - *Post-operative outcomes.*

Data	Laparoscopic CME (n=31)	Open CME (n=35)	p value
Flatus recovery time (SD) (day)	2.32+0.79	2.80+0.75	0.015
Liquid intake time (SD) (day)	3.35+0.95	4.65+2.08	0.001
Time to mobilization (day)	1.0	1.4+0.6	0.001
Length of stay (SD) (day)	6.93+2.6	9.11+3.1	0.001
Re-operation	1 (3.2%)	1 (2.9%)	0.723
30-day mortality	0	0	
30-day complication	11 (35.5%)	15 (42.9%)	0.541
Respiratory complications	6 (19.4%)	5 (14.3%)	0.411
Wound site infection	3 (9.7%)	6 (17.1%)	0.303
Anastomotic leakage	2 (6.5%)	1 (2.9%)	0.454
Wound dehiscence	0	2 (5.7%)	0.494
Post-operative ileus	2 (6.5%)	5 (14.3%)	0.433
Clavien-Dindo grade (grade 3-4-5)	2 (6.5%)	4 (11.4%)	0.483
Clavien-Dindo grade			
None	20 (64.5%)	20 (57.1%)	0.674
Grade 1	5 (16.1%)	5 (14.3%)	
Grade 2	4 (12.9%)	6 (17.1%)	
Grade 3a	1 (3.2%)	3 (8.6%)	
Grade 3b	1 (3.2%)	0	
Grade 4	0	1 (2.9%)	

Legend: SD: Standard Deviation

Laparoscopic CME is not easy to perform due to the complex and variable vascular anatomy of the right hemicolon [21,32].

This study showed that open and laparoscopic CME techniques were similar in terms of age, sex, tumor localization, comorbidities, previous abdominal surgery and additional malignancy. These results were in agreement with those reported by Sheng *et al*. who stated that the open and laparoscopic techniques were the same in age, sex distribution, tumor localization, and potential comorbidities ($p>0.05$) [37]. Kim *et al.* demonstrated that open CME group had a higher rate of ASA score 3 or higher compared with the laparoscopic CME group (24.2% *vs.* 11.2%), though age, gender, BMI, and prior abdominal surgery did not differ between the open and laparoscopic CME groups [24]. However, Vendramini *et al.* observed a statistically significant difference between patients aged 60 years and older with a higher prevalence of open surgery ($p=0.049$) [38]. In our study, there was a statistically significant difference between the studied groups because of the incision of the open technique (185.57±20.8 mm) was longer than the laparoscopic technique (76.54±38.5 mm) ($p<0.001$). These results were consistent with the study by Negoi *et al.* who reported that patients in the laparoscopic group had a shorter incision and the mean incision length was 14.01 cm ($p<0.001$) [39].

In studies comparing open and laparoscopic colon surgery in the literature, operative time is a frequently investigated variable. In this context, Farinetti *et al.* reported in a comparative analysis between laparoscopy and open colectomy that the average duration of surgery was 177.9 minutes (surgical time) with a minimum of 110 and a maximum of 360 minutes for open colectomy with significant differences according to type of surgery performed and the patient's clinical history, and the average duration of surgery for open right hemicolectomy was 175.4 minutes [40]. However, they found that the average duration was 293 minutes (range: 135-520 minutes) for laparoscopy with significant differences depending on the portion of the intestinal tract removed. In right-sided colon cancers, dissection along the SMA and SMV with CVL and exposure of the gastrocolic trunk of Henle is very difficult, leading to concerns over prolonged operative time and increased intraoperative and postoperative morbidity rates. The mean operative time after laparoscopic CME ranges from 136 min to 269 min in the literature [20,24,26,41]. We observed that there was a statistically significant difference between laparoscopic and open procedures in terms of operative time (mean:140.8 min, range: 120-200 min) because the laparoscopic technique took more time than the open technique (mean:165.4 min, range:120–240 min) ($p<0.001$). This result was consistent with the study by Li *et al.* who demonstrated that the operative time in the laparoscopic CME group (3.02±0.55 hours) was statistically significantly longer than in the open CME group (2.58±0.50 hours) ($p=0.004$) [42]. However, Bae *et al.* [32] and Kim *et al.* [24] showed similar operative times between the open and laparoscopic CME groups (194 min *vs.*179 min, and 175 min *vs.* 175min, respectively). Conversely, Stergios *et al.* reported a statistically significant reduction in operative time for the laparoscopic group (mean: 182 min, range: 103-341 min) compared to the open group (mean: 242 min, range: 71-584 min) ($p=0.006$) because of surgical teams had more skills and experience in laparoscopic technique [43]. In addition, intraoperative blood loss during the laparoscopic technique was lower than the open technique in our study (mean: 44.8 mL, range:15-200 mL *vs.* mean: 88.1 mL, range: 25-280 mL, respectively) ($p<0.001$). The length of hospital stay in the laparoscopic group was shorter than the open group (6.9 days *vs.* 9.1 days, respectively) ($p<0.001$). These results were consistent with the study of Bae et al. who reported significant differences between open and laparoscopic groups in blood loss (53.5 *vs.* 161.6 mL) ($p<0.001$) and length of hospital stay (9 *vs.* 13 days) ($p<0.001$) [32].

Laparoscopic CME has been shown to be appropriate for pathological outcomes in case series [17,26,44]. Gouvas *et al.* found that laparoscopic CME specimens were comparable in terms of the distance of the tumor to high ligation, the shortest distance of the intestine to high ligation, intestinal length, and mesocolon surface area compared to those of open CME [22]. In our study, there was no statistically significant difference between laparoscopic and open groups in terms of tumor size, TNM classification and histopathological findings ($p>0.05$). Our results were so similar to that of Huang *et al.* that they reported no significant difference in TNM classification between open and laparoscopic techniques ($p=0.961$) [23].

Both CME techniques have focused on maintaining mesocolon integrity, vertical removal through CVL, and longitudinal removal with a sufficient length of intestinal resection. Although there are objective limits for surgical excision in terms of mesocolon quality and CVL, there is no clear consensus on bowel length or margin length [45]. The traditional 5 cm- or 10 cm-rule for proximal and distal margins needs to be examined in this CME era [46]. By this time, there are limited CME data regarding proximal resection margins [20,47,48] (13.5 cm in our open group and 14.7 cm in our laparoscopic group), distal resection margins [20,47,48] (15.8 cm in our open group and 17.1 cm in our laparoscopic group), total length of the specimen [22,44,49] (32.7 cm in our open group and 35.1 cm in our laparoscopic group). We confirmed that specimen length, proximal and distal margin length, and R0 resection rate were similar between open and laparoscopic CME groups. These results were in agreement with those reported by Kim *et al.* who stated that the open and laparoscopic techniques were similar for proximal margin, distal margin and specimen length ($p>0.05$) [24]. We believe that central ligation of the feeding vessels, sharp dissection preserving mesocolic integrity, and adequate proximal and distal margins can have favorable oncologic outcomes compared with conventional colon cancer surgery. In addition, tumor-specific CME is required for right-sided colon cancer. Accordingly, the cecum or proximal ascending colon (CME for right hemicolectomy) and distal ascending colon should be differentiated for hepatic flexure or

proximal transverse colon (CME for extended right hemicolectomy).
Surgical treatment of colorectal cancer requires to retrieve enough lymph nodes for proper tumor staging. Kang et al. have shown that the effect of the number of lymph nodes harvested after right colon cancer surgery on oncologic outcomes has recently been emphasized [21].
Recent studies have suggested that the number of retrieved lymph nodes and the proportion of involved to uninvolved nodes are significant prognostic factors even in the cases with stage III disease, in which improved survival is seen with increased lymph node yield, with the optimum number of nodes ranging between 15 and 28 [19]. West *et al.* demonstrated that CME with CVL remove more tissue around a tumor with end result of a maximal lymph node harvest [4]. Bae *et al.* showed similar number of nodes harvested between open and laparoscopic CME groups (28 *vs.* 27) [32]. However, Kim *et al.* observed that there was a statistically significant difference between the open and laparoscopic CME groups in terms of retrieved lymph nodes (31 *vs.* 27) (p=0.012) [24]. In the literature, the mean number of harvested lymph nodes ranges from 28 to 35.4 for open CME and 19 to 34.4 after laparoscopic CME for right-sided colon cancer [2,17,20,22,32,41,44,47,48]. In our study, the mean number of lymph nodes retrieved in the laparoscopic CME and open CME groups was close to each other (29.8±8 *vs.* 31.3±13, respectively) (p=0.592). All these nodal counts, either by open or laparoscopic CME, satisfy the current recommendation of a minimum requirement of 12 lymph nodes [50] .
The short-term outcomes of the laparoscopic CME group were comparable to those of the open CME group. A shorter time for soft diet, reduced length of stay, and shorter time to mobilization, similar postoperative complication rates have been reported in laparoscopic CME [32]. In our study, we observed that laparoscopic CME provided a series of short-term benefits such as shorter time to mobilization, early regain of bowel motion, shorter time to soft diet, and reduced length of stay.
Patients who undergo laparoscopic CME with CVL have comparable incidence of postoperative complications in the literature. Procacciante *et al.* investigated post-operative ileus in open and laparoscopic hemicolectomy for cancer, and they randomized patients into three groups with different surgical approaches: open technique with extensive manipulation of intestinal loops (Group A), open technique with minimal manipulation (Group B) and laparoscopic technique (Group C) [51]. Detection of bowel sounds occurred after 2.18 days in Group A, after 1.35 days in Group B and after 1.19 days in Group C. Return of flatus occurred after 3.51 days in Group A, after 2.53 days in Group B and after 2.30 days in Group C. Passage of stool occurred after 4.48 days in Group A, after 3.75 days in Group B and after 3.61 days in Group C. In all end-points analyzed, differences between Group A and Group B, and between Group A and Group C were significant (p<0.01), whereas the differences between Group B and Group C were not significant (p>0.01). Chen *et al.* reported that patients in the laparoscopic CME group regained bowel function earlier than open surgery group (52.8±12.3 hours *vs.* 86.4±17.1 hours, respectively) (p<0.001) and reported a comparable incidence of postoperative complications (p>0.05) [52]. In our study, flatus recovery time was 2.32±0.79 days for open CME group and 2.80±0.75 days for laparoscopic CME group, and the difference was statistically significant (p=0.015). Although post-operative ileus rate was numerically high in open CME group (14.3%) in comparison to laparoscopic CME group (6.5%), this was not statistically significant in our series (p=0.433). We think that this may be due to the relatively small number of patients in both groups. Our study showed that there was no statistically significant difference in 30-day postoperative complications between laparoscopic and open CME groups (35,5% and 42,9%, respectively) (p=0.541). Huang *et al.* reported that there was no statistical difference between the two groups in terms of postoperative complications (p=0.222), and the rates of postoperative complications for laparoscopic and open CME groups were 4% and 12%, respectively [23]. However, Kim *et al.* observed that there was a statistically significant difference between the two groups in terms of postoperative complications (p=0.036), and the rates of postoperative complications for laparoscopic and open CME groups were 23,3% and 36,4%, respectively [24]. In our study, in the laparoscopic CME group, the postoperative complication rate was 35.5%, and these complications were managed conservatively [ileus (n=2), anastomotic leakage (n=2), respiratory complications (n=6), and wound infection (n=3)]. Two patients had more than one complication. The complication rate in the open CME group was 42.9%. These complications occurred in 15 patients, including respiratory complications (n=5), ileus (n=5), wound infection (n=6), wound dehiscence (n=2), and anastomotic leakage (n=1). Four patients had more than one complication. Although our 30-day postoperative complication rates seems to be higher than those reported in the literature, the rates of Clavien-Dindo grades 3 and 4 were 6.5% and 11.4%, respectively
Laparoscopic right hemicolectomy is a relatively routine surgical procedure characterized by well-defined indications and by different surgical techniques. Even if the laparoscopic approach is considered superior to open surgery in the short-term outcomes, it is sometimes not applicable because some factors could obstruct its feasibility and safety. Del Rio *et al.* reported that laparoscopic conversion rates in right colectomy are 12-16% in their analysis of indication for laparoscopic right colectomy and conversion risks [53]. They described the different type of risk factors related to open conversion: patient-related, disease-related and surgeon-related factors, procedural factors and intraoperative complications.

In our study, laparoscopic CME surgery was completed by converting to open surgery in one patient (3.2%) due to technical reasons. Actually, this rate seems to be relatively high compared to the reported rate of 1.9% in the literature [20,32]. It is difficult to compare the published studies directly, as definitions of conversion are heterogeneous and conversion is related to diverse factors such as level of technical skill or tumor factors. Laparoscopic CME requires a steep learning curve due to technical difficulty [18] and conversion is sometimes inevitable even in an experienced surgeon's hand. Thus, during laparoscopic CME, conversion to open CME should be regarded as an alternative surgical approach to improve surgical outcome.

Conclusion

In conclusion, the pathological (specimen length, resection margin length, number of lymph nodes harvested and R0 resection) and short-term results of the laparoscopic CME group were comparable to those of the open CME group. The results of our study showed that laparoscopic CME with CVL was associated with shorter incision length, less operative blood loss, shorter time to mobilization, early regain of bowel motion, shorter time to soft diet, and reduced length of stay compared with open surgery. Based on these results, laparoscopic CME can be considered as a routine elective approach for right-sided colon cancer. Further research in a large series is needed to determine whether favorable short- and long-term outcomes after laparoscopic CME can be reproduced compared to open CME for right-sided colon cancer.

Riassunto

Scopo dello Studio: L'emicolectomia destra per escissione mesocolica completa (EMC) laparoscopica mostrerebbe benefici comparabili a breve termine, nonché esiti patologici e oncologici per la chirurgia a cielo aperto. Lo scopo di questo studio era di confrontare la tecnica laparoscopica e la EMC aperta per i tumori del colon sul lato destro in termini di campioni patologici e risultati a breve termine.

Materiale e Metodi: I dati dei pazienti sottoposti a EMC laparoscopica (n=31) e EMC aperto (n=35) per adenocarcinoma del colon destro tra gennaio 2016 e giugno 2019 sono stati analizzati retrospettivamente. Sono stati confrontati dati demografici, parametri preoperatori, peroperatori e postoperatori e campioni di patologia dei due gruppi.

Risultati: Non ci sono state differenze statistiche tra il gruppo laparoscopico di EMC e il gruppo aperto di EMC in termini di età, sesso, indice di massa corporea, posizione del tumore, punteggio dell'American Society of Anesthesiologists (ASA), presenza di comorbidità, storia di altre neoplasie e precedente chirurgia addominale (p>0,05). I pazienti nel gruppo EMC laparoscopico presentavano lunghezze d'incisione più brevi, tempi operativi più lunghi, minore perdita di sangue operativa, tempi di mobilizzazione più brevi, recupero precoce del movimento intestinale, tempo più breve per dieta leggera, durata ridotta della degenza e dimensioni del tumore più piccole (p<0,05). Il numero medio di linfonodi raccolti in gruppi laparoscopici e di EMC aperti non era statisticamente significativo (29,83+8,90 e 31,34+13,10, rispettivamente). Non ci sono state differenze statistiche in termini di lunghezza del campione tra i gruppi laparoscopici e aperti di EMC (35,19+9,8 cm e 32,71+11,12 cm, rispettivamente). Il tasso di complicanze postoperatorie di 30 giorni era più elevato nel gruppo EMC aperto (35,5% contro 42,9%, rispettivamente), ma non statisticamente significativo (p>0,05).

Conclusioni: Patologici (lunghezze dei campioni, lunghezze dei margini di resezione, numero di linfonodi e resezione R0) e risultati a breve termine del gruppo laparoscopico di EMC erano comparabili. Inoltre, la EMC laparoscopica ha conferito benefici a breve termine in termini di lunghezze di incisione più brevi, minore perdita di sangue operativa, riduzione dei tempi di mobilizzazione, recupero precoce dei movimenti intestinali, minor tempo di dieta leggera e riduzione della durata della degenza ospedaliera. Sulla base di questi risultati, la EMC laparoscopica può essere considerata come un approccio elettivo di routine per il carcinoma del colon destro.

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