

return of bowel function, early initiation of oral food, and short hospital stay (9-11). Some investigators have disputed the supremacy of laparoscopic approach in right-sided colon cancer in terms of clinical results and technical challenges in relation to vascular diversification (12,13). Studies have demonstrated the practicability of laparoscopic CME for right-sided colon cancer (14-16). Laparoscopic technique requires initial adaptation to meet CME requirements (17). Different laparoscopic right hemicolectomy techniques have been proposed for CME (14,18-20), but this process has high complexity in terms of vascular variability (21), and the procedure carries an important complication risk.

The objective of the present study was to define the laparoscopic CME technique in right-sided colon cancers and to present the short-term results of our cases to ensure the practicability and reliability of this technique.

MATERIAL and METHODS

The present study was planned as a single center and retrospective study. The data of the patients who underwent laparoscopic CME with the diagnosis of right colon adenocarcinoma in our clinic between January 2017 and January 2019 were analyzed. Written informed consent was obtained from each patient for surgical intervention prior to surgery. This study was approved by the Institutional Review Board of our institute (IRB No. 14.06.2019/89/46).

Surgical Technique

The patient was put in the supine position with a mild lean towards left with Trendelenburg on the operating table. While the resident was on the right side of the patient, the operator and the cameraman were on the left side. A 12 mm camera port was inserted under the umbilicus. A total of 3 ports were put into the abdomen, one 5 mm on the right side, and one 5 mm and one 10 mm on the left side. The trocar on right side was for traction, whereas the trocars on the left side were used as the main operating ports. The abdomen was explored after the operating area was provided. The procedure was divided into 4 sections: dissection, ligation of the vessels, release of the colon, extraction of the specimen and resection.

Stage 1

Right colon was pulled upward, along with the ileocolic mesentery, and incision was made under the ileocolic mesentery and then retroperitoneum was entered. Thus, the terminal ileum, cecum and the ascending colon mesentery were totally mobilized in a medial to lateral and a caudal to cranial fashion. Mobilization was continued until the duodenum and pancreatic head, the origin of the superior mesenteric vasculature and the origin of the middle colic vessels were completely visualised (Figures 1 A and B).

Stage 2

The ileocolic and middle colic pedicles were pulled upward and dissection of the anterior peritoneal sheath was

Figure 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)



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

performed along the left side of the superior mesenteric artery with transection from the roots of ileocolic and right colic vessels. The en bloc lymphadenectomy of the anterior side of the superior mesenteric vein was performed from the ileocolic vessels to the gastroduodenal trunk of Henle. While the middle colic veins were cut from their roots in the tumors of the hepatic flexure and transverse colon, they were clipped from the right branches in the cecum and ascending colon tumors. This technique was applied in all right-sided colon cancers (Figure 2).

Stage 3

Omentum was separated by cutting the right side. Gastrocolic ligament was opened by preserving the gastroepiploic vessels and released from the lateral ligaments of the right colon (Figure 3).

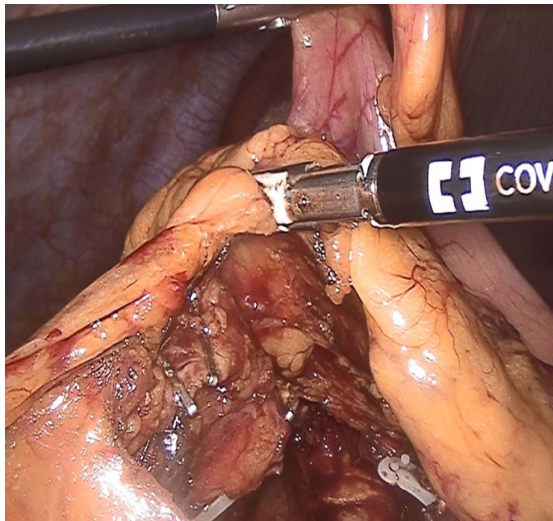


Figure 3. Separation of the right colon from the lateral ligaments and complete releasing the right colon

Stage 4

The freed colon on the right side was taken out of the abdomen through a mini-incision made on the umbilicus by using a wound protector. Both resection and a side-to-side anastomosis were performed with stapler, while looking out for safe surgical margins. A Jackson-Pratt drain was placed near the anastomosis (Figure 4).

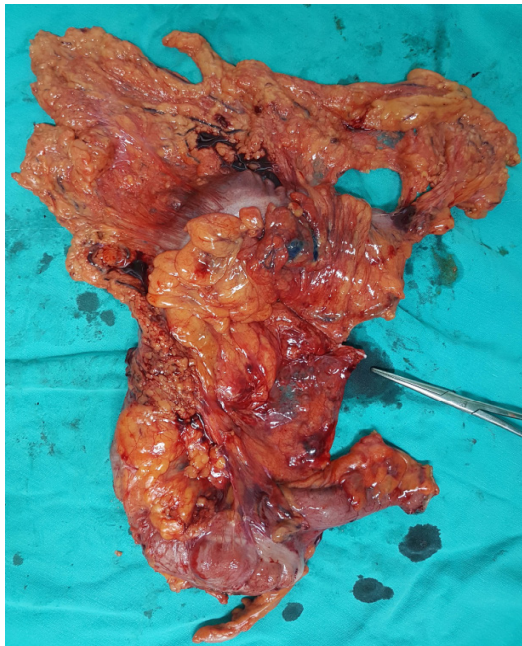


Figure 4. The appearance of the surgical specimen

The clinical and pathological data of the patients were prospectively recorded and stored. Any deviation from postoperative normal course was accepted as a complication. Negative events occurring within the first

30 days after surgery were evaluated as morbidity and mortality.

Postoperative measurements and data analysis

Pathology samples were analyzed in accordance with the 7th edition of the American Joint Cancer Committee (AJCC) and the criteria of the Union for International Cancer Control (UICC). Tumor size, specimen length, and surgical resection margins were calculated from formalin-fixed specimens. Complications were rated by Clavien-Dindo classification (22).

Continuous data were presented as mean (standard deviation) or median (range) and categorical data as frequency.

RESULTS

The clinical and demographic characteristics of the patients are shown in Table 1. There were 23 patients in our study and the mean (SD) age was 61.9 ± 14.8. Seven of the patients were over 70, and 3 were over 80 years of age. Four patients were ASA class 3. Fifty-two percent of the patients had comorbidities. Two patients had a history of different system malignancies (1 patient had lung cancer and 1 patient had breast cancer).

Table 1. Patient demographic and clinical characteristics for the 23 patients under study	
Data	Cases (n=23)
Mean Age (SD)	61.9±14.8
Gender	
Female	11 (47.8%)
Male	12 (52.2%)
Mean BMI (SD)	25±4.36)
Tumor location	
Cecum	4 (17.4%)
Ascending	10 (43.5%)
Hepatic flexure	7 (30.4%)
Transverse	2 (8.7%)
ASA class	
ASA 1	5 (21.7%)
ASA 2	14 (60.9%)
ASA 3	4 (17.4%)
Presence of comorbidities	
No	11 (47.8%)
Yes	12 (52.2%)
History of other malignancy	
No	21 (91.3%)
Yes	2 (8.7%)
Previous abdominal surgery	
No	17 (73.9%)
Yes	6 (26.1%)
SD: Standard Deviation BMI: Body Mass Index	

The mean (SD) body mass index (BMI) was 25 ± 4.3 , while there were 4 patients with a BMI over 30. Twenty-six percent of the patients had a history of prior abdominal surgical intervention.

Operative technical data are explained in Table 2. The mean (SD) operation time was 168.2 ± 33 minutes, the maximum operation time was 240 minutes, and the minimum operation time was 100 minutes. The median blood loss was 30 mL, the maximum blood loss was 160 mL, and the minimum blood loss was 15 mL. One patient had an intraoperative complication. One operation was converted to open surgery.

Table 2. Data of surgical procedure for the 23 patients under study	
Data	Cases (n=23)
Mean time of surgery (SD)	168.2 ± 33.1 min
Intraoperative complications	
No	22 (95.7%)
Yes	1 (4.3%)
Median blood loss (range)	30 (15-160) mL
Conversion	
No	22 (95.7%)
Yes	1 (4.3%)
SD: Standard Deviation	

Histopathological examination results of surgical specimens are given in Table 3. The mean (SD) specimen length was 34.2 ± 9.7 cm, the mean (SD) proximal surgical margin length was 14 ± 9.75 cm, the mean (SD) distal surgical margin length was 16.6 ± 8.9 cm, and the mean (SD) tumor diameter was 4.0 ± 1.7 cm. The mean (SD) number of harvested lymph nodes was 31.9 ± 7.7 , the median number of retrieved lymph nodes was 30, and the minimum number of retrieved lymph nodes was 17. In 87% of patients, the depth of invasion was T3/T4 tumors and 52.2% of patients were N (+). One patient had liver metastasis. The radial surgical margin of all specimens was negative.

Postoperative complications were evaluated according to Clavien-Dindo classification and summarized in Table 4. One or more complications occurred in 39% of the patients. Grade 1 and 2 complications were developed in 7 of these patients, and grade 3 complications were occurred in 2 patients. In one of the patients, a grade 3b postoperative complication was taken place and the patient was re-operated due to anastomotic leakage.

Postoperative outcome of the patients is presented in Table 5. There was no perioperative mortality. Wound site infection developed in 13% of the patients. Anastomotic leakage occurred in two cases and one of these patients was re-operated. The mean (SD) postoperative length of stay was 7.2 ± 2.8 days and the maximum hospital stay was 15 days.

Table 3. Data of histopathological examination for the 23 patients under study	
Data	Cases (n=23)
Mean length of specimen (SD)	34.2 ± 9.7 cm
Mean length of proximal margin (SD)	14 ± 8.2 cm
Mean length of distal margin (SD)	16.6 ± 8.9 cm
Mean tumor size (SD)	4 ± 1.7 cm
Mean number of retrieved lymph nodes (SD)	31.9 ± 7.7
Tumor grade	
High	5 (21.7%)
Moderate	10 (43.5%)
Low	8 (34.8%)
Depth of invasion (T)	
T1	1 (4.3%)
T2	2 (8.7%)
T3	4 (17.4%)
T4a	16 (69.6%)
Nodal involvement (N)	
N0	11 (47.8%)
N1a	7 (30.4%)
N1b	3 (13.2%)
N2a	1 (4.3%)
N2b	1 (4.3%)
Presence of metastasis (M)	
M0	22 (95.7%)
M1a	1 (4.3%)
AJCC / UICC TNM stage	
Stage 1	3 (13.0%)
Stage 2A	4 (17.4%)
Stage 2B	4 (17.4%)
Stage 3B	10 (43.5%)
Stage 3C	1 (4.3%)
Stage 4A	1 (4.3%)
Neural invasion	15 (65.2%)
Lymphovascular invasion	19 (82.6%)
SD: Standard Deviation AJCC: American Joint Cancer Committee UICC: Union for International Cancer Control	

Table 4. Post-operative complications of the 23 patients under study	
Data	Cases (n=23)
Post-operative complications	
None	14 (60.9%)
Grade 1	2 (8.7%)
Grade 2	5 (21.7%)
Grade 3a	1 (4.3%)
Grade 3b	1 (4.3%)

Table 5. Post-operative outcome of the 23 patients under study

Data	Cases (n=23)
RBC transfusion	6 (26.1%)
Respiratory complications	3 (13.0%)
Flatus recovery time (days)	
1	4 (17.4%)
2	8 (34.8%)
3	10 (43.5%)
4	1 (4.3%)
Liquid intake time (days)	
2	4 (17.4%)
3	10 (43.5%)
4	6 (26.1%)
5	2 (8.7%)
6	1 (4.3%)
Wound site infection	3 (13.0%)
Anastomotic leakage	2 (8.7%)
Re-operation	1 (4.3%)
Mean postoperative length of stay (SD) (days)	7.2±2.8
RBC: Red Blood Cell SD: Standard Deviation	

DISCUSSION

Colectomies performed according to CME principles in right-sided colon cancers have showed improvements in the quality of surgical specimens (providing clean surgical margins, high number of removed lymph nodes) (5,23,24). It was first introduced by Hohenberger et al. (4), and is now routinely performed in several hospitals in the West and more often in the Far East (7,15,25,26). There are also studies on radical lymph node dissections including Japanese D3 lymphadenectomy, CME and CVL (27-28).

CME described by Hohenberger et al. and Japanese CME were similar in cecum and ascending colon cancers, but vary in cancers of hepatic flexure and transverse colon (29). Kocher maneuver is not performed in Japanese CME right hemicolectomy, lymphadenectomy is confined to the anterior aspect of the superior mesenteric vein and bowel resection is performed by the direction of the arterial supply (27,28). Therefore, the dimension of colonic resection is larger in the Hohenberger's procedure (29).

Laparoscopic surgery in colon cancer has now become the standard surgical method after multiple randomized trials (9,10,30). Although laparoscopic surgery is nowadays regarded as the standard treatment for right-sided colon cancer resection, laparoscopic CME right hemicolectomy is seen as a difficult procedure (14,17-20).

Our CME procedure was performed by following the principles recommended by Hohenberger et al. The efficiency of this technique has been demonstrated by potentially high rates of curative (R0) resections in which the longitudinal and circumferential surgical margins

without involvement by the tumor are achieved and a sufficient number of lymph nodes are dissected.

The results of the present study coincide with other studies on standard right hemicolectomy from Europe and America (9-11,31-33). It is also tantamount to studies on CME right hemicolectomy performed in Western countries (14,33,34) and Eastern countries (15,20,26,35,36).

Laparoscopic CME right hemicolectomy is recognized as a complicated procedure involving various technical challenges (37). Developments in robotic surgery can help overcome some of these difficulties.

Despite the comprehensive analysis of robotic colorectal surgery, there are only a few comparative studies in relation to laparoscopic and robotic right hemicolectomy (38). While those studies have demonstrated that robotic CME right hemicolectomy is secure and practicable, they were not able to show the superiority of a robotic approach in comparison to a laparoscopic approach (39,40).

In our study, 7 of the patients were older than 70 years and 3 of them were over 80 years of age. Four patients were ASA class 3. Fifty-two percent of the patients had an additional disease. Two of our patients had a history of malignancy of other systems. There were 4 patients with a BMI over 30. Twenty-six percent of the patients had a history of prior abdominal surgical intervention. No perioperative or postoperative mortality was observed and postoperative complication ratio was comparable to previous studies. Wound site infection rates were slightly higher in our study.

CONCLUSION

In conclusion, short-term results for right-sided colon cancers were evaluated and laparoscopic CME technique was found to be safe and feasible and it improved the quality of surgical specimens.

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REFERENCES

1. Siani LM, Pulica C. Stage I-IIIC right colonic cancer treated with complete mesocolic excision and central vascular ligation: quality of surgical specimen and long term oncologic outcome according to the plane of surgery. *Minerva Chir* 2014;69:199-208.

2. Heald RJ, Husband EM, Ryall RD. The mesorectum in rectal cancer surgery--the clue to pelvic recurrence? *Br J Surg* 1982;69:613-6.
3. Hohenberger W, Merkel S, Weber K. Lymphadenectomy with tumors of the lower gastrointestinal tract. *Chirurg* 2007;78:217-25.
4. Hohenberger W, Weber K, Matzel K, et al. Standardized surgery for colonic cancer: complete mesocolic excision and central ligation--technical notes and outcome. *Colorectal Dis* 2009;11:354-64.
5. Merkel S, Weber K, Matzel KE, et al. Prognosis of patients with colonic carcinoma before, during and after implementation of complete mesocolic excision. *Br J Surg* 2016;103:1220-9.
6. West NP, Hohenberger W, Weber K, et al. Complete mesocolic excision with central vascular ligation produces an oncologically superior specimen compared with standard surgery for carcinoma of the colon. *J Clin Oncol* 2010;28:272-8.
7. Kim NK, Kim YW, Han YD, et al. Complete mesocolic excision and central vascular ligation for colon cancer: Principle, anatomy, surgical technique, and outcomes. *Surg Oncol* 2016;25:252-62.
8. Green BL, Marshall HC, Collinson F, et al. Long-term follow-up of the Medical Research Council CLASICC trial of conventional versus laparoscopically assisted resection in colorectal cancer. *Br J Surg* 2013;100:75-82.
9. Fleshman J, Sargent DJ, Green E, et al. Laparoscopic colectomy for cancer is not inferior to open surgery based on 5-year data from the COST Study Group trial. *Ann Surg* 2007;246:655-62.
10. Colon Cancer Laparoscopic or Open Resection Study Group, Buunen M, Veldkamp R, Hop WC, et al. Survival after laparoscopic surgery versus open surgery for colon cancer: long-term outcome of a randomised clinical trial. *Lancet Oncol* 2009;10:44-52.
11. van der Pas MH, Haglind E, Cuesta MA, et al. Laparoscopic versus open surgery for rectal cancer (COLOR II): short-term outcomes of a randomised, phase 3 trial. *Lancet Oncol* 2013;14:210-8.
12. Rondelli F, Trastulli S, Avenia N, et al. Is laparoscopic right colectomy more effective than open resection? A meta-analysis of randomized and nonrandomized studies. *Colorectal Dis* 2012;14:447-69.
13. Alsabilah J, Kim WR, Kim NK. Vascular structures of the right colon: incidence and variations with their clinical implications. *Scand J Surg* 2017;106:107-15.
14. Adamina M, Manwaring ML, Park KJ, et al. Laparoscopic complete mesocolic excision for right colon cancer. *Surg Endosc* 2012;26:2976-80.
15. Kang J, Kim IK, Kang SI, et al. Laparoscopic right hemicolectomy with complete mesocolic excision. *Surg Endosc* 2014;28:2747-51.
16. Kim IY, Kim BR, Choi EH, et al. Short-term and oncologic outcomes of laparoscopic and open complete mesocolic excision and central ligation. *Int J Surg* 2016;27:151-7.
17. Senagore AJ, Delaney CP, Brady KM, et al. Standardized approach to laparoscopic right colectomy: outcomes in 70 consecutive cases. *J Am Coll Surg* 2004;199:675-9.
18. Croner R, Hohenberger W, Strey CW. Comparison of open vs. laparoscopic techniques in complete mesocolic excision (CME) during right hemicolectomy. *Zentralbl Chir* 2015;140:580-2.
19. Benz S, Tam Y, Tannapfel A, et al. The uncinate process first approach: a novel technique for laparoscopic right hemicolectomy with complete mesocolic excision. *Surg Endosc* 2016;30:1930-7.
20. Xie D, Yu C, Gao C, et al. An optimal approach for laparoscopic D3 lymphadenectomy plus complete mesocolic excision (D3+CME) for right-sided colon cancer. *Ann Surg Oncol* 2017;24:1312-3.
21. Kuzu MA, İsmail E, Çelik S, et al. Variations in the vascular anatomy of the right colon and implications for right-sided colon surgery. *Dis Colon Rectum* 2017;60:290-8.
22. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004;240:205-13.
23. Storli KE, Søndena K, Furnes B, et al. Short term results of complete (D3) vs. standard (D2) mesenteric excision in colon cancer shows improved outcome of complete mesenteric excision in patients with TNM stages I-II. *Tech Coloproctol* 2014;18:557-64.
24. Kotake K, Mizuguchi T, Moritani K, et al. Impact of D3 lymph node dissection on survival for patients with T3 and T4 colon cancer. *Int J Colorectal Dis* 2014;29:847-52.
25. Ishiguro M, Higashi T, Watanabe T, et al; Japanese Society for Cancer of the Colon and Rectum Guideline Committee. Changes in colorectal cancer care in Japan before and after guideline publication: a nationwide survey about D3 lymph node dissection and adjuvant chemotherapy. *J Am Coll Surg* 2014;218:969-77.
26. Matsuda T, Iwasaki T, Sumi Y, et al. Laparoscopic complete mesocolic excision for right-sided colon cancer using a cranial approach: anatomical and embryological consideration. *Int J Colorectal Dis* 2017;32:139-41.
27. Watanabe T, Itabashi M, Shimada Y, et al. Japanese Society for Cancer of the Colon and Rectum (JSCCR) Guidelines 2014 for treatment of colorectal cancer. *Int J Clin Oncol* 2015;20:207-39.
28. West NP, Kobayashi H, Takahashi K, et al. Understanding optimal colonic cancer surgery: comparison of Japanese D3 resection and European complete mesocolic excision with central vascular ligation. *J Clin Oncol* 2012;30:1763-9.
29. Pedrazzani C, Lauka L, Sforza S, et al. Management of nodal disease from colon cancer in the laparoscopic era. *Int J Colorectal Dis* 2015;30:303-14.
30. Jayne DG, Thorpe HC, Copeland J, et al. Five-year follow-up of the Medical Research Council CLASICC trial of laparoscopically assisted versus open surgery for colorectal cancer. *Br J Surg* 2010;97:1638-45.

31. Hanna NN, Onukwugha E, Choti MA, et al. Comparative analysis of various prognostic nodal factors, adjuvant chemotherapy and survival among stage III colon cancer patients over 65 years: an analysis using surveillance, epidemiology and end results (SEER) Medicare data. *Colorectal Dis* 2012;14:48-55.
32. Benz S, Barlag H, Gerken M, et al. Laparoscopic surgery in patients with colon cancer: a populationbased analysis. *Surg Endosc* 2017;31:2586-95.
33. Storli KE, Søndena K, Furnes B, et al. Outcome after introduction of complete mesocolic excision for colon cancer is similar for open and laparoscopic surgical treatments. *Dig Surg* 2013;30:317-27.
34. Siani LM, Lucchi A, Berti P, et al. Laparoscopic complete mesocolic excision with central vascular ligation in 600 right total mesocolectomies: Safety, prognostic factors and oncologic outcome. *Am J Surg* 2017;214:222-7.
35. Liang JT, Lai HS, Lee PH. Laparoscopic medial-to-lateral approach for the curative resection of right-sided colon cancer. *Ann Surg Oncol* 2007;14:1878-9.
36. Zou L, Xiong W, Mo D, et al. Laparoscopic radical extended right hemicolectomy using a caudal-to-cranial approach. *Ann Surg Oncol* 2016;23:2562-3.
37. Fabozzi M, Cirillo P, Corcione F. Surgical approach to right colon cancer: From open technique to robot. State of art. *World J Gastroint Surg* 2016;8:564-73.
38. Petrucciani N, Sirimarco D, Nigri GR, et al. Robotic right colectomy: A worthwhile procedure? Results of a meta-analysis of trials comparing robotic versus laparoscopic right colectomy. *J Minim Access Surg* 2015;11:22-8.
39. Spinoglio G, Marano A, Bianchi PP, et al. Robotic right colectomy with modified complete mesocolic excision: Long-Term oncologic outcomes. *Ann Surg Oncol* 2016;23:684-91.
40. Yozgatli TK, Aytac E, Ozben V, et al. Robotic complete mesocolic excision versus conventional laparoscopic hemicolectomy for right-sided colon cancer. *J Laparoendosc Adv Surg Tech A* 2019.