# **Original Research Article**

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# Laparoscopic versus open complete mesocolic excision with central vascular ligation in right colon cancer

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# **ABSTRACT**

**Background:** The purpose of this study was to compare between laparoscopic and open complete mesocolic excision (CME) with central vascular ligation (CVL) in right colon cancer.

**Methods:** From January 2016 to December 2018, a prospective cohort study of 60 patients who diagnosed as operable right sided colon cancer was performed. The patients were classified into laparoscopic CME with CVL and open CME with CVL groups. Demographic variables, comorbidities, tumor location, intraoperative parameters, duration of hospital study, histopathological findings, postoperative complications and follow up data were compared between the two groups. Demographic variables included age and sex distribution. Intraoperative parameters included incision length, operative time and operative blood loss.

**Results:** 60 patients were selected in this study. Both groups were the same in the age and sex distribution, potential comorbidities and tumor location. Patients in the Laparoscopic CME with CVL group had shorter incision lengths, longer operative times, less operative blood loss, shorter hospital stay, less number of retrieved lymph nodes, the same TNM (tumor nodes metastasis) classifications, similar histopathological findings and comparable incidence of postoperative complications.

**Conclusions:** Laparoscopic CME with CVL procedure is a safe, valid and feasible surgical method for right colon cancers.

Keywords: Right colon cancer, Mesocolic excision

# INTRODUCTION

Colorectal cancer (CRC) incidence and mortality rates vary markedly around the world. Globally, CRC is the third most diagnosed cancer in males and the second in females.<sup>1</sup>

The right colon has a thin wall, a large caliber, and its contents are liquid; thus, obstruction is a late event in right colon cancer. Also, right colonic tumors grow large enough to be palpable through the abdominal wall before other symptoms appear.<sup>2</sup>

Curative treatment for right colon cancer includes resection of the tumor-bearing bowel segment. There are standard types of operations, depending on the location of the tumor. These types of resections are depended on the knowledge of lymphatic drainage and lymph node anatomy.<sup>3</sup>

Right sided hemicolectomy is the standard type of operation for cancers in the caecum and the ascending colon.<sup>4</sup> In 2009, Hohenberger, demonstrated the term of complete mesocolic excision (CME), whose theory is mainly consisted of two concepts in fetal anatomy and

surgical oncology: sharp dissection of the mesocolic plane and the parietal plane. CME helps to keep the colonic mesentery intact, clarify the dissected area from central lymph nodes, emphasize the importance of transecting colon-feeding blood at the root, and increase the range of longitudinal enterotomy. So, CME provides a standardization of surgeries for colon cancer.<sup>5</sup>

The traditional approach to right colon cancer is through open exploration but this approach has more blood loss, prolonged postoperative hospital stay, sever postoperative pain and delayed recovery.<sup>6</sup>

Laparoscopic right colectomy (LRC) for right cancer colon became a well-established procedure in the field of colorectal surgery. It has many advantages: reduction in postoperative pain, duration of regain of bowel function, and the period of hospital stay.<sup>7</sup>

The purpose of the present study was to differentiate between laparoscopic and open complete mesocolic excision with central vascular ligation in right colon cancer as regards technical feasibility, positive and negative impacts of both procedures.

#### **METHODS**

Between January 2016 and December 2018, 60 patients admitted to Menoufia university hospitals and diagnosed as operable right sided colon cancer were enrolled in this study. The study criteria included only operable cases of right colon cancer by (CT scan criteria) which include: no permeation of surrounding fat planes, no encasement of major vascular structures, no extensive local spread and no distant metastases or peritoneal infiltration. The exclusion criteria included all cases with perforation or obstruction, metastatic colon cancer and patients undergoing colectomy including another part of the colon than right colon. All enrolled patients were divided randomly into the laparoscopic CME with CVL group (A) and the open approach group (B). This study has been reported in line with the STROCSS criteria.

# Surgical procedures

Laparoscopic CME group (A)

A high-definition laparoscope was used, and the patient was at a modified lithotomy position. After achieving pneumoperitonium (12 mm Hg), a 12-mm trocar was placed through an incision just above the umbilicus, and a 30-degree laparoscope was inserted through the 12-mm trocar. The second 10-mm trocar was introduced at the upper left quadrant of the abdomen for the major acting port. The third 5-mm trocar was introduced at the lower left quadrant for the second major active port. The fourth and the fifth 5-mm trocars were introduced at the upper right and lower right quadrants. A medial to lateral dissection was done in most cases, but when the origin of ileocolic pedicles was not clearly identified, the

dissection was alternated with lateral to medial fashion. The procedures of 'A medial to lateral dissection' were as follows: the terminal ileum with the ascending colon were dissected off through the embryological plane and the dissection between the mesocolon and Gerota's fascia continued to the duodenum and head of the pancreas. Once the ileocolic vessels were identified, the mesenteric lymph nodes were removed along the vessels while exposing the ventral side of the superior mesenteric vein (SMV) and artery (SMA). The ileocolic vessels were ligated at the root of the SMV and SMA, and the dissection continued cephalic to the right colic vessels, the gastrocolic trunk of Henle, and the middle colic vessels in case of extended right hemicolectomy for lesion in hepatic flexure. Then, the middle colic vessels were identified and dissected at the roots of the SMA and SMV (Figure 1). CME was performed according to the tumor location. For ceacal and proximal ascending colon cancers, right hemi-colectomy was performed and the right branches of the middle colic artery and vein were ligated. For hepatic flexure and proximal transverse colon cancers, extended right hemi-colectomy was performed and the roots of the middle colic artery and vein were ligated (Figure 1).

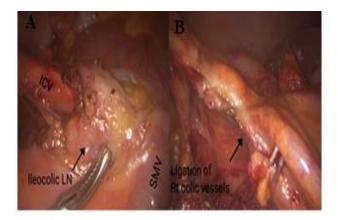


Figure 1: This was a 65 years old male with right colon cancer. (A) Identification of superior mesenteric vein and artery (SMV/SMA) and ileocolic vein and artery (ICV/ICA) and the ileocolic lymph nodes (LNs) dissection at the root of these vessels. (B) Ligation of right (Rt) colic vessels.

Omentectomy was done just below the gastroepiploic vessels. Then the mobilized colon was exteriorized through umbilical mini-laparotomy and transected with adequate resection margin either extracorporeal stapled (hand-sewn end to end anastomosis) was fashioned and 2 tube drains were placed in subhepatic and right paracolic sulci) or an intra-corporeal anastomosis was performed (eliminating problems with extracorporeal delivery and unnecessary traction on the mesentery). The terminal ileum and transverse colon were aligned in side to side isoperistaltic fashion and enterostomies were made for insertion of an endostapler which was fired through these enterostomies creating the croach of the final anastomosis (Figure 2). The resulting common enterostomy was then

put under tension using 3 traction sutures and the enterostomy was closed with another load of endostapler completing the side to side anastomosis (Figure 3).

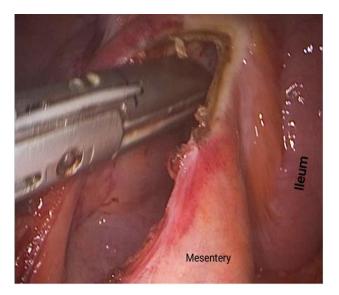


Figure.2: This was 65 years old male with right colon cancer. Separation of the terminal ileum mesentery.

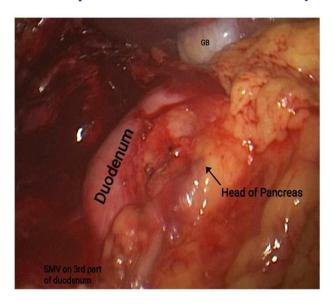


Figure.3: This was 65 years old male with right colon cancer. The surgical field after complete procedure. Superior mesenteric vein (SMV), gall bladder (GB).

Open CME group (B)

In this group, the patient was placed in a supine position. A midline incision was done. Then mobilization of the colon from paracolic gutter through avascular plane of *Toldt* and safe guarding of the ureter, gonadal vessels and duodenum were done. After that the ascending colon and hepatic flexure were released from gall bladder by dividing hepatocolic ligament and mobilized from the duodenum and Gerota's fascia. Greater omentum was separated by ligation and division, and cared about SMV

and its branches and bleeding. Ligation of ileocolic and right colic vessels from their origin in case of right hemicolectomy, or ligation of ileocolic, right colic and middle colic vessels in extended right hemicolectomy to clear nodes was performed. Peritoneal incision on the mesentery of the terminal 15 cm ileum was completed and that part of the ileum was also mobilized. Occlusion clamps were placed at the line of resection. Another occlusion clamp was placed on the right 1/3rd to ½ of the transverse colon. Once right colon unit was completely mobilized, the division of the terminal ileum and transverse colon between clamps was done. After that constructing a safe ileocolic anastomosis (hand Sewen by single layer) was performed. Then closure of the mesenteric defect, insertion of tube drain and closure of the abdomen were done.

# Measurement of variables between both groups

Both groups were differentiated in terms of demographics variables, intraoperative parameters, hospital stay histopathological findings, duration, postoperative parameters and follow up data. Demographics variables included age, gender distribution, tumor localization, and comorbidities. Intraoperative parameters included (incision length, operative time and blood loss) and the postoperative parameters included regain of bowel motion and postoperative complications. Histopathological findings were the number of retrieved lymph nodes, TNM classification, the results of the pathology reports. All patients were observed by the surgical outpatient clinic and data in the medical records were checked.

### Statistical analysis

Data was collected and entered to the computer using SPSS (Statistical Package for Social Science) program for statistical analysis, (version 20; Inc., Chicago. IL). Two types of statistics were done: descriptive statistics which included (quantitative data as mean, SD, median, and range and qualitative data as frequency and percent) and analytical statistics which included (Fisher exact test and Mann Whitney test). P-value was considered statistically significant when it was less than 0.05

# **RESULTS**

The study included 60 patients with right cancer colon meeting the inclusion criteria. All operations in both groups were done by the same surgical team. There was four cases from the laparoscopic group converted to open right hemicolectomy with CME due to intraoperative bleeding (n=3) and severe adhesions (n=1).

The demographic variables of the 2 groups are summarized in Table 1. The statistical analysis showed no significant difference between the studied groups as regards age, sex distribution, potential comorbidities and tumor location (all p-value >0.05). Patients were 14

(46.7%) males and 16 (53.3%) females in both groups. Their ages ranged from 50 to 70 years with a mean age of

58.33±5.88 in laparoscopic technique and 59.93±5.20 in open technique.

Table 1: Demographic variables between the studied groups.

Studied variables	Laparscopic right hemicolecomy with CME	Open right hemicolectomy with CME	Statistical test	P-value
Age				
Mean SD	58.33±5.88	59.93±5.20	0.50%	0.42
Median	58.00	60.00	0.78*	0.43
Range	51-71	50-70		
Gender	No (%)	No (%)		
Male	14 (46.7)	14 (46.7)		
Female	16 (53.3)	16 (53.3)		
DM				
No	26 (86.7)	22 (73.3)	1.67	0.19
Yes	4 (13.3)	8 (26.7)	1.07	
HTN				
No	24 (80.0)	26 (86.7)		
Yes	6 (20.0)	4 (13.3)	0.48	1.48
<b>Tumour location</b>				
Ascending colon	14 (46.7)	16 (53.3)	0.36	0.83
Ceacum	10 (33.3)	8 (26.7)	0.30	0.05
Hepatic flexure	6 (20.0)	6 (20.0)		

SD- standard deviation, CME- complete mesocolic excision, DM- diabetes mellitus, HTN-hypertension, \*Mann Whitney test, \*\*chi square test.

The intraoperative parameters and hospital stay duration of both groups are listed in Table 2. This study showed that there was a statistical high significant difference between laparoscopic and open groups regarding the incision length as the incision of the open technique (mean= $17.5\pm0.25$ ) is longer than the laparoscopic technique (mean= $6.02\pm0.44$ , p value <0.001). Also, there was a statistical high significant difference between the

two procedures regarding the operative time as the laparoscopic technique took more time (range=140–205 min) than the open technique (range=90-175 min, p value <0.001). Regarding intraoperative blood loss and the hospital stay, the intraoperative blood loss during the laparoscopic technique was less than the open technique (65-190 ml vs. 127- 360 ml, p value <0.001) and hospital stay in laparoscopic CME group is shorter than the open group (3- 6 days vs. 5-7 days, p value <0.001).

Table 2: The intraoperative parameters and hospital stay duration of both groups.

Studied variables	Laparscopic right hemicolecomy with CME	Open right hemicolectomy with CME	Statistical test	P-value
<b>Incision length</b>	(cm)			
Mean SD	6.02±0.44	17.5±0.25		
Median	6.0000	18.5	87.86	< 0.001
Range	5.20-6.80	15.2-20	67.60	<0.001
Operative time	(min)			
Mean SD	180.0±20.0	157.34±15.0		
Median	179.00	155.00	3.5	< 0.001
Range	140-205	90-175	3.3	<0.001
Blood loss (ml)				
Mean SD	92.00±24.986	200.6±50.5		
Median	85.00	220.00		
Range	65-190	127-360	7.47	< 0.001
Hospital stay d	uration (day)			
Mean SD	4.40±0.910	5.73±0.799	4.26	< 0.001
Median	4.00	6.00	4.20	<0.001
Range	3-6	5-7		

SD- standard deviation, CME- complete mesocolic excision, Cm- centimeter, Min- minute, ml- milliter, \*Mann Whitney test.

Table 3: Histopathological findings and postoperative parameters between both groups.

Studied variables	Laparscopic right hemicolecomy with CME	Open right hemicolectomy with CME	Statistical test	P-value			
Tumour size (cm)	- C.1.22	O.V.Z.Z					
Mean±SD	4.31±3.50	5.25±4.34		0.51			
Median	4.5	5	0.65*				
Range	1-11	1-18					
No. of retrieved LNs							
Mean±SD	27.0±8.23	32.0±10.3		0.15			
Median	26	29	1.46*				
Range	18-36	20-49					
	No (%)	No (%)					
TNM classification							
I	4 (13.3)	4 (13.3)		0.93			
П	12 (40.0)	14 (46.7)	0.30				
III	14 (46.7)	12 (40.0)	0.30	0.93			
Histopathology							
Well differentiated	6 (20)	8 (26.7)		0.56			
Moderatly differentiated	16 (53.3)	14 (46.7)					
Poor differentiated	6 (20%)	8 (26.7)	2.70				
Mucinous	2 (6.7)	0 (0)	2.70				
Post-operative complication	ons						
No	21 (70.0)	22 (73.3)	0.08*	0.77*			
Yes	9 (30.0)	8 (26.7)					
Ileus							
No	28 (93.3)	27 (90)	0.2	1.00			
Yes	2 (6.7)	3 (10)	_				
Regain of bowel motion (d	lay)						
Mean±sd	2.9±0.78	3.1±0.56		0.42			
Median	3	4	0.81				
Range	2-4	1-5					
Anastomotic leak	<u>८</u> न	1 3					
No	29 (96.7)	30 (100)	1.02	1.00			
Yes	1 (3.3)	0 (0.0)	1.02				
Anastomotic bleeding	1 (3.3)	0 (0.0)					
No	27 (90.0)	30 (100.0)	1.40	0.23			
Yes	3 (10.0)	0 (0.0)	1.70				
Wound infection	3 (10.0)	0 (0.0)					
No	29 (96.7)	27 (90)	0.27	0.60			
	1 (3.3)		0.27				
Yes	1 (3.3)	3 (10)					
Intraabdominal sepsis							
No	28 (93.3)	29 (96.7)	0.35	1.00			
Yes	2 (6.7)	1 (3.3)					
Incisional hernia							
No	30 (100.0)	29 (93.3)	1.02	1.00			
Yes	0 (0.0)	1 (6.7)					

SD- standard deviation, CME- Complete mesocolic excision, LNs- lymph nodes, TNM- tumor node metastasis, \*Mann Whitney test.

Histopathological findings and postoperative parameters are demonstrated in Table 3. In this study, both groups had similar tumor size, similar TNM classification and the same histopathological findings (p value >0.05). Regarding the number of harvested lymph nodes (LNs),

there was no statistical significant difference between laparoscopic CME and open CME groups and it was (18-36 LNs and 20-49 LNs, respectively). Also, there was no statistical significant difference between the studied groups regarding postoperative complications as ileus,

anastomotic leak, postoperative bleeding, wound infection, intra-abdominal sepsis and incisional hernia (p value <0.05). The regain of bowel motion was so close in both groups (2-4 days vs. 1-5 days, p value= 0.42).

According to the follow up duration, there was no statistical significant difference between the laparoscopic and open groups (11-24 months vs. 12-23 months, p value >0.05). During the follow-up of the patients, no tumor recurrence, metastasis, nor cancer-related deaths were observed in either group.

#### **DISCUSSION**

Complete excision of the primitive dorsal mesentery along the anatomo-embryological and surgical planes by means of CME is now the standard of care for colonic cancers. Technical strategies for CME include two aspects: sharp separation of visceral and parietal fascia, and ligation at the root of central supply vessels and more radical lymph node dissection for improving oncological outcomes. However, the right hemicolectomy is performed routinely worldwide, the feasibility and safety of complete mesocolic excision has recently been showed in open and laparoscopic surgeries. <sup>10</sup>

In the present study, we compared between laparoscopic and open complete mesocolic excision with central vascular ligation in right colon cancer as regards technical feasibility, positive and negative impacts of both techniques.

The statistical analysis showed no significant difference between the laparoscopic and open CME groups as regards age and sex distribution, this ensures that the demographic data has no impact on the results of the study indicting no bias in it. Regarding the comorbidities of the patients, analysis of the results showed that, there were no statistical significant difference between the studied groups regarding diabetes mellitus and hypertension. Also in this study, both groups were the same regarding the tumor location.

These results were in agreement with those reported by Sheng et al, 2017 who stated that, the open and laparoscopic techniques were the same in age, sex distribution, tumor localization, and potential comorbidities (all p>0.05)  $^{11}$ . However, Vendramini et al, 2012 observed that, there was a statistical significant difference (p=0.049) with a higher prevalence of open procedure between the patients aged 60 or over  $^{12}$ .

In this study, there was a statistical high significant difference between the studied groups regarding the incision length as the incision of the open technique (mean= $17.5\pm0.25$ ) was longer than the laparoscopic technique (mean= $6.02\pm0.44$ , p value <0.001). This result agreed with the study done by Negoi et al, 2017 who reported that, patients from the laparoscopic group had a

shorter incision, with a mean difference of 14.01 cm  $(95\% \text{ CI} - 14.35 \text{ to } -13.66, \text{ p} < 0.001)^{13}$ .

The duration of surgery remained one of the largest obstacles for laparoscopic CME. In our study, there was a statistical high significant difference between the laparoscopic and open procedures regarding the operative time as the laparoscopic technique take more time (range= 140-205 min) than the open technique (range= 90-175 min, p value <0.001). These result was in agreement with Li et al, 2018 who demonstrated that, the operative time in the laparoscopic CME group was statistically longer than that in the open CME group  $(2.58\pm0.50 \text{ versus } 3.02\pm0.55 \text{ hours, } P=0.004)^{-14}$ . On the other hand, Stergios et al, 2017 reported that, there was a statistically significant decrease of the operative time for the laparoscopic group [(182 min (103-341 min)] compared to the open group [(242 min (71-584 min)] (p=0.006) as their surgical team had more skills and experience in laparoscopic technique.<sup>15</sup>

Regarding intraoperative blood loss and the hospital stay, there was a statistical high significant difference between the studied groups as the intraoperative blood loss during the laparoscopic technique was less than the open technique (65-190 ml vs. 127-360ml, p value <0.001) and hospital stay in laparoscopic group was shorter than the open group (3-6 days vs. 5-7 days, p value <0.001). These results were in agreement with Bae et al, 2014 who reported that, there was significant differences between open and laparoscopic groups in blood loss (53.5 vs. 161.6 ml, p<0.001) and hospital stay duration (9 vs. 13 days, p<0.001) preferred the laparoscopic CME group. 10

In this study, there was no statistical significant difference between the laparoscopic and open groups regarding the tumor size, TNM classification and the histopathology findings (p value >0.05). The number of harvested LNs in laparoscopic CME and open CME groups were (18-36 LNs and 20-49 LNs, respectively). These results were so close to the study done by Huang et al, who reported that, there was no significant difference in TNM classification between the open and laparoscopic techniques (p=0.961). The lengths of resected specimens in the laparoscopic and open groups were the same (216 $\pm$ 71 vs. 204 $\pm$ 51 mm, respectively, p=0.322), as were the average number of harvested lymph nodes (14 $\pm$ 6 vs. 13 $\pm$ 5, respectively, p=0.313). <sup>16</sup>

Kang et al, 2014 demonstrated that, the effect of the number of harvested lymph nodes after right colon cancer surgery on oncological outcomes has recently been emphasized. Harvesting an adequate number of lymph nodes is essential for accurate tumor staging in the surgical treatment of colorectal cancer. Some 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.<sup>17</sup> West et al, 2010 demonstrated that, complete mesocolic excision with central vascular ligation remove more tissue around a tumor with end result of a maximal lymph node harvest.<sup>18</sup>

This present study showed that, there was no statistical significant difference between the laparoscopic and open CME groups regarding postoperative complications (p value >0.05). The regain of bowel motion was so close in both groups (2-4 days vs. 1-5 days, p value= 0.42). The postoperative complication rate in the laparoscopic CME group was 30% (9/30), and the complications included ileus (n=2), anastomotic leak (n=1) that managed conservatively, postoperative bleeding (n=3) that converted to open technique, intra-abdominal sepsis (n=2) and wound infection (n=1). The complication rate in the open CME group was 26.7% (8/30), including ileus (n=3), wound infection (n=3), intra-abdominal sepsis (n=1) and incisional hernia (n=1).

Chen et al, 2017 reported that, the patients in laparoscopic CME group had earlier regain of bowel function after the operation (52.8±12.3 h vs. 86.4±17.1 h, P<0.001) and comparable incidence of postoperative complications (P>0.05) compared to the patients in the open group.<sup>19</sup> Huang et al, reported that, there was no statistical difference between both groups (p=0.222) regarding the post-operative complications and their rates in laparoscopic CME and open CME groups were 4% (2/53) and 12% (6/49) respectively.<sup>16</sup>

Regarding the follow up duration, there was no statistical significant difference between laparoscopic CME and open CME groups (11-24 months vs. 12-23 months, p value >0.05). During the follow-up, no tumor recurrence, metastasis, or cancer-related deaths were noted in both groups. These results were close to the study of Sheng et al, 2017 who demonstrated that, the median follow up duration of the laparoscopic and open groups was 20.1±4.6 months. 11

# **CONCLUSION**

The results of our study demonstrated that laparoscopic complete mesocolic excision with central vascular ligation procedure is associated with smaller incisions, less operative blood loss, earlier recovery after operation, and shorter hospital stay compared with open procedure. Also, laparoscopic procedure is maintaining intact embryological envelope of the mesocolon and allowing high tight ligation but the open technique is still superior shorter operative time, less postoperative complications and the number of harvested lymph nodes. However, we recommended that further studies on large number of patients are needed to show the preference of laparoscopic CME in the surgical treatment of right cancer colon compared to the open technique.

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Ethical approval: The study was approved by the local ethics committee of Menoufia University Hospitals and the Unique Identifying Number (UIN) from the ClinicalTrials.gov of the study is NCT03826446

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