



Original research

Short-term and oncologic outcomes of laparoscopic and open complete mesocolic excision and central ligation

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H I G H L I G H T S

- Pathologic and oncologic outcomes of the laparoscopic CME group were comparable.
- Moreover, laparoscopic CME conferred short-term benefits in terms of lower rates of postoperative complications.
- Based on these results, laparoscopic CME can be considered as a routine elective approach for right-sided colon cancer.

A R T I C L E I N F O

Article history:

Received 9 September 2015

Received in revised form

21 January 2016

Accepted 1 February 2016

Available online 3 February 2016

Keywords:

Colonic neoplasms

Laparoscopy

Mesocolic excision

Morbidity

Survival rate

A B S T R A C T

Purpose: To evaluate the pathologic, short-term and oncologic outcomes of laparoscopic and open complete mesocolic excision (CME) and central ligation for right-sided colon cancer.

Methods: All patients (n = 215) underwent elective CME either by open surgery (n = 99) or laparoscopy (n = 116).

Results: Mean number of retrieved lymph nodes (31 vs. 27, p = 0.012) was greater in the open CME group. Between the open and laparoscopic CME groups, there were no differences of length of the specimen (44.3 cm and 43.2 cm), ileum (14 cm and 13.3 cm), or colon (30.3 cm and 29.8 cm), respectively. Proximal and distal margins were similar. Mean operative time was similar between the open and laparoscopic CME groups (175 min vs. 178 min). The rate of 30-day postoperative complications (36.4% vs. 23.3%, p = 0.036) was higher in the open CME group. There were no differences in 3-year overall survival rates (86.9% vs. 95.5% in stage II disease and 70.2% vs. 90.7% in stage III disease) or recurrence-free survival rates (84.5% vs. 84.8% in stage II disease and 64.2% vs. 68.9% in stage III disease) between the open and laparoscopic CME groups.

Conclusions: Pathologic (specimen lengths, resection margin lengths, number of lymph nodes, and R0 resection) and oncologic outcomes of the laparoscopic CME group were comparable. Moreover, laparoscopic CME conferred short-term benefits in terms of lower rates of postoperative complications, reduced 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.

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1. Introduction

Traditional colon cancer surgery includes en bloc resection of the affected colonic segment with its lymph node bearing mesentery and ligation of draining vessels. Recently, Hohenberger et al.

[1] described the concept of complete mesocolic excision (CME) that emphasized sharp dissection between the mesocolon and retroperitoneum along the Toldt's fascia and removal of the specimen as one intact mesocolon package. The authors also underscored techniques of central vascular ligation to remove all regional lymph nodes, and ensure sufficient specimen length. In Japan, lymph nodes are grouped based on their locations and D3 lymphadenectomy is recommended for clinically node-positive disease [2]. D3 lymphadenectomy for colon cancer is a widely adopted surgical procedure in Asian countries, including Korea and China

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[3]. Although the extent of surgery between CME and D3 dissection may not be quite the same, these two techniques share excellent oncologic outcomes in common [1,4–6].

In clinical practice, it is difficult to perform CME for right-sided colon cancer due to frequent anatomic variations of the branching vessels from the superior mesenteric artery (SMA) and superior mesenteric vein (SMV), and dissection difficulties during excision of the mesocolon along the SMA and SMV [3,7,8]. Laparoscopic surgery for colon cancer has clear short-term benefits such as reduced postoperative pain and shorter hospital stay when compared with conventional laparotomy. The oncologic safety of laparoscopic surgery has been also shown in randomized clinical trials [9–11]. However, applying laparoscopy to CME for right colon cancer is difficult, and there remains controversy as to whether favorable oncologic outcomes of open CME can be reproduced with laparoscopic CME [12–15]. To date, there have been several single-arm studies evaluating laparoscopic CME [6,8,14,16,17] and two comparative studies between open and laparoscopic CME surgeries [18,19].

We hypothesized that laparoscopic CME for right-sided colon cancer would show comparable oncologic outcomes to open surgery if the laparoscopic version was harmonized with standardized operative procedures, experienced colorectal surgeons, and a well-trained surgical team. This study aimed to evaluate the pathologic, short-term and oncologic outcomes of laparoscopic and open CME and central ligation for right-sided colon cancer.

2. Methods

2.1. Patients

This was a retrospective, observational clinical cohort study at a tertiary university hospital, and STROBE guidelines were used for reporting [20]. All clinical investigations were conducted according to the principles expressed in the Declaration of Helsinki and were approved by the Institutional Review Board of Wonju Severance Christian Hospital (YWMR-15-5-012). All participants provided their written informed consent to participate in this study and the ethics committee approved this consent procedure. Eligibility criteria included having histologically-confirmed colon cancer and undergoing (extended) right hemicolectomy for right-sided colon cancer between 1 March 2008 and 31 December 2013. All patients ($n = 215$) underwent elective complete mesocolic excision either by open surgery ($n = 99$) or laparoscopy ($n = 116$). Conversion to open surgery occurred in 16 laparoscopic cases (13.8%). Patients undergoing non-resectional or bypass surgery, an emergent operation, or multivisceral resection were excluded from the study population. Patients were also excluded when they had distant metastasis (stage IV disease), synchronous multiple or metachronous colon cancer, and hereditary colon cancer (familial adenomatous polyposis or hereditary nonpolyposis colorectal cancer).

Preoperative staging included colonoscopy with biopsy, abdominopelvic computed tomography (CT) scan, and positron emission tomography. In suspected cases, chest CT scan was used to identify thoracic organ metastases. The current National Comprehensive Cancer Network guideline does not support routine use of PET [21]. Although lacking firm evidences, PET is a promising tool as a preoperative imaging modality for colon cancer [22]. Thus, we performed preoperative PET scan routinely.

2.2. Study endpoints

The primary endpoint was to compare pathologic and short-term clinical outcomes between laparoscopic and open CME for right-sided colon cancer. Secondary endpoints were to compare

oncologic outcomes between laparoscopic and open CME for right-sided colon cancer.

2.3. Surgical procedures

All CME surgeries were performed by two colorectal surgeons with extensive open and laparoscopic surgical experience [23,24]. During the study period, we emphasized preservation of the intact visceral layer of the mesocolon and high ligation of the feeding vessels during colon cancer surgery, and were strictly adherent to traditional oncologic principles such as en bloc removal and no-touch technique. After standardized preoperative preparation, CME and central vascular ligation were performed in patients with right-sided colon cancers (Fig. 1). The operative principles underlying the laparoscopic approach were the same as those of CME through laparotomy. For laparoscopic CME, we utilized one 10 mm port at the umbilicus for a camera and three 5 mm working ports (the left upper, left lower, and right lower quadrants). In difficult cases, another 5 mm port at the right upper quadrant was used. After placement of the trocars, the patient was placed in a Trendelenburg and right tilt position. A medial to lateral dissection was preferred in most cases, but when the roots of ileocolic vessels were not clearly visualized, the dissection was alternated with lateral to medial fashion. Complete mobilization of the terminal ileum and the right colon was performed along the embryological plane. Dissection between the mesocolon and Gerota's fascia identified the duodenum and head of the pancreas. Once the ileocolic vessels were identified, the mesocolon package containing lymph nodes was cleared along the vessels while exposing the ventral side of the superior mesenteric vein and artery. The ileocolic vessels were ligated at the root of the superior mesenteric vessels and the dissection continued cephalad to the right colic vessels, the gastrocolic trunk of Henle, and the middle colic vessels. The right colic vessels, if present, were identified and ligated at the root. The gastrocolic trunk has a number of anatomic variations, and so we skeletonized the gastrocolic trunk and identified the vascular anatomy. Whenever possible, the anterior superior pancreaticoduodenal vein and right gastroepiploic vein were preserved, and only the colic branch was transected. Then, the middle colic vessels were identified and skeletonized at the roots of the superior mesenteric vessels.

Tumor-specific CME was performed in our institution. For cecal and proximal ascending colon cancers, right hemicolectomy 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 hemicolectomy was performed and the roots of the middle colic artery and vein were ligated. The Kocher maneuver was not performed routinely. Omentectomy was performed just below the gastroepiploic vessels and, unless infiltrated by the tumor, right gastroepiploic vessels were preserved. The mobilized colon was transected with adequate resection margin. Extracorporeal stapled or hand-sewn anastomosis was performed and one closed suction drain was placed.

2.4. Adjuvant chemotherapy and follow-up

After recovery from surgery, all patients with stage II and III disease were recommended to receive chemotherapy according to National Comprehensive Cancer Network (NCCN) guidelines [21]. All cases were discussed at the weekly multidisciplinary team meeting. Stage II patients with high-risk features (T4, histologic grade 3 or 4, lymphovascular involvement, bowel obstruction, T3 lesions with localized perforation, positive resection margin, or perineural invasion) were considered for oxaliplatin-containing regimens. Chemotherapy regimens included fluoropyrimidine

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