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MULTIMEDIA ARTICLE

"Top down no-touch" technique in robotic complete mesocolic excision for extended right hemicolectomy with intracorporeal anastomosis

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Abstract

Background Proper identification of the mesocolic vessels is essential for achieving complete mesocolic excision (CME) in cases of colon cancer requiring an extended right hemicolectomy. In robotic procedures, we employed a "top down technique" to allow early identification of the gastrocolic trunk and middle colic vessels. The aim of our study was to illustrate the details of this technique in a series of 12 patients.

Methods The top down technique consists of two steps. First, the omental bursa was entered to identify the right gastroepiploic vein. Tracing down this vein as a landmark, the gastrocolic trunk was exposed, branches of this trunk and the middle colic vessels were divided. Second, dissection was directed to the ileocolic region and proceeded in an inferior-to-superior direction along the superior mesenteric vein to divide the ileocolic and right colic vessels consecutively. The ileotranverse anastomosis was created intracorporeally.

Results There were 8 males and 4 females with a mean age of 64.8 ± 16.9 years and a mean body mass index of 25.6 ± 3.7 kg/m^2. All the procedures were completed successfully. No conversions occurred. The mean operative time and blood loss were 312.1 ± 93.9 min and 110.0 ± 89.9 ml, respectively. The mean number of harvested lymph nodes was 45.2 ± 11.1. The mean length of hospital stay was 7.6 ± 4.7 days. Two patients had intraoperative complications and two had postoperative complications. There was no disease recurrence at a mean follow-up period of 10.4 ± 7.1 months.

Conclusions The top down technique appears to be useful in robotic CME for an extended right hemicolectomy. Early identification of the gastrocolic trunk and middle colic vessels via this technique may prevent inadvertent vascular injury at the mesenteric root of the transverse colon.

Keywords No-touch technique · Robotic surgery · Complete mesocolic excision · Extended right hemicolectomy

Introduction

Complete mesocolic excision (CME) for colon cancer [1] has been shown to produce an oncologically superior specimen and better oncologic outcomes than standard colectomy [2]. CME for right-sided colon cancer is based on high ligation of the vascular structures and radical oncologic resection along the superior mesenteric vein (SMV) [1–3]. This technique was originally performed as open surgery. Subsequently the oncologic safety of the laparoscopic approach in CME [4–6], and the technical feasibility of robotic CME have been reported [7, 8].

However, applying CME to resection of right-sided colon cancer is more challenging than its application to resection of left-sided cancer [9, 10], perhaps due to the complex

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vascular anatomy of the right colon. Misrecognition of the vascular anatomical variations, especially at the gastrocolic trunk (Henle's trunk), can lead to bleeding that can be difficult to control [11]. Cancers localized in the distal ascending colon, hepatic flexure or proximal transverse colon require an extended right hemicolectomy and thus proper identification and ligation of the middle colic vessels at origin is paramount to achieve CME. The cranial-to-caudal approach [12, 13] is suggested to allow easy access to the gastrocolic trunk and early division of middle colic vessels. We employed a modified version of this approach, called the top down technique, in our robotic procedures. The aim of this study was to illustrate the details of this technique during robotic CME and present short-term outcomes.

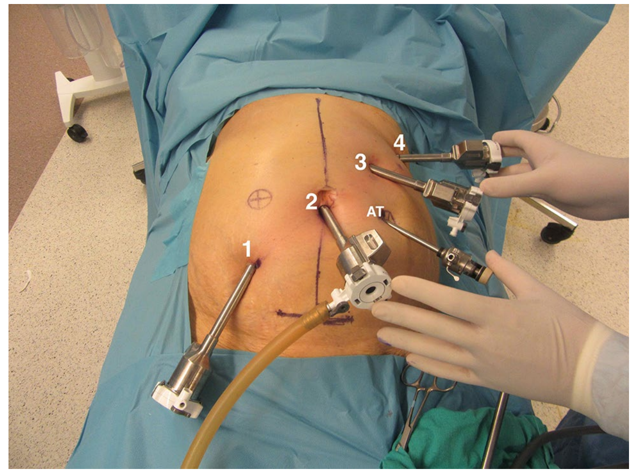

Fig. 1 Trocar setup. Four 8-mm robotic trocars and one 5-mm assistant trocar (AT) were used. Later in the operation, trocar #4 was changed to a 12-mm robotic trocar in order to introduce the stapler for bowel anastomosis

Materials and methods

This study was approved by the Institutional Review Board (IRB Reference Number: 2016-13/3). Between April 2015 and June 2017, 32 patients had a robotic right-sided colectomy for cancer. The procedures were performed by three colorectal surgeons who are highly experienced in both laparoscopic and robotic surgery [8, 14]. Patients were followed-up by the departments of general surgery and medical oncology. The operation was performed using Turnbull's medial-to-lateral, no-touch isolation technique [15] through 4 robotic trocars and one assistant trocar. The da Vinci Xi® Surgical System (Intuitive Surgical Inc., Sunnyvale, CA, USA) was used in this operation with the robotic cart docked from the right side of the patient.

The top down technique consisted of two steps (see video). In the first step, the patient was placed in a 30°-reverse Trendelenburg position with the operating table tilted to the left side. An 8-mm robotic camera was attached to trocar #2, an 8-mm double fenestrated bipolar forceps to trocar #1, 8-mm monopolar curved scissors to trocar #3, and an 8-mm double fenestrated tip-up grasper to trocar #4 (Fig. 1). Similar to the original cranial-to-caudal approach [12, 13], dissection began superiorly in the gastrocolic ligament to enter the omental bursa. First, the right gastroepiploic artery was identified, and then, clipped with Hem-o-lok clips (Weck, Teleflex, Research Triangle Park, NC, USA) and divided. Then, the right gastroepiploic vein (rGEV) was dissected, and tracing down the rGEV as a landmark, dissection was performed caudally until the gastrocolic trunk was identified. The rGEV was clipped and divided in a similar fashion. Next, the anterior side of the SMV was exposed at the inferior border of the neck of the pancreas and the mesocolic branches of the gastrocolic trunk and the root of the middle colic vein and artery were isolated, clipped and divided individually. The transverse mesocolon was separated from the pancreatic head and duodenum. This was accompanied by lymph node dissection along the anterior and lateral side of the SMV in this region. The right half of the greater omentum at a length of 10–15 cm from the tumor was dissected off together with the subpyloric lymph nodes so as to include them with the final specimen. In this step, control of these vascular structures and mobilization of the mesenteric root in this critical region helped avoid vascular injury due to traction of the mesocolon during the rest of the operation.

In the second step, the robot was undocked so that the patient could be placed in a 30°-Trendelenburg position, and then, redocked. The Trendelenburg position in this step helped retract the transverse mesocolon and omentum into the upper abdomen. With the same trocar configuration, the dissection was first directed to the ileocolic region where the ileocolic artery and vein were isolated, clipped and divided, individually. Then, dissection proceeded in a cephalad direction up to the level of the middle colic vein pedicle, completing mesocolic excision along the SMV. During this dissection, the right colic vessels, if present, were divided.

Next, the medial-to-lateral mesenteric dissection was performed staying between the embryological planes just over Toldt's fascia, preserving the duodenum, right ureter and gonadal vessels. After the terminal ileum and transverse colon were dissected free of their mesentery, trocar #4 was changed to a 12-mm trocar and bowel transection was performed using robotic staplers (EndoWrist, 45-mm stapler, Intuitive Surgical Inc., Sunnyvale, CA, USA) introduced through this trocar. Following bowel transection, the hepatic flexure and lateral attachments of the ascending colon were fully mobilized. After completing CME, an intracorporeal side-to-side ileotransverse anastomosis was created using robotic staples. The opening in the anastomosis was closed with a double-layered suture technique using a 3-0 V-Loc (V-Loc™, Covidien, Boston, MA, USA) and silk sutures. The specimen was extracted through a suprapubic transverse incision.

Results

In the study period, a total of 12 patients (8 males) had robotic CME using the top down technique. The mean age of the patients was 64.8 ± 16.9 years and the mean body mass index was 25.6 ± 3.7 kg/m^2. The tumor was localized in the distal ascending colon, hepatic flexure and proximal transverse colon in 6, 3 and 3 patients, respectively (Table 1). The mean operative time and blood loss were 312.1 ± 93.9 min and 110.0 ± 89.9 ml, respectively. All the procedures were completed with no conversions. There were no intraoperative complications except in 2 patients (17%) with minor vascular injury. Both these injuries occurred at the origin of a jejunal branch of the SMV and were repaired uneventfully with 5/0 Prolene sutures. Postoperative complications occurred in 2 patients (17%), ileus in one and pulmonary embolism in the other. Ileus was managed with nasogastric tube decompression and pulmonary embolism was treated with intravenous unfractioned heparin therapy. The mean first time of bowel movement and soft diet intake were 3.8 ± 2.2 and 3.7 ± 2.1 days, respectively. Mean length of hospital stay was 7.6 ± 4.7 days (Table 2).

Histopathological evaluation revealed that in 9 cases (75%) resection was in the mesocolic plane, with a complete excision of mesocolon and root ligation of supply vessels. In 2 cases resection was in the intramesocolic plane and one case in the muscularis propria plane. All the surgical margins were clear. The mean size of the specimen and distance between the high vascular ligation and tumor was 37.8 ± 9.9 and 12.3 ± 4.0 cm, respectively. The mean number of harvested lymph nodes was 45.2 ± 11.1 (median 43; range 31–62) (Table 3). There was no disease recurrence after a mean follow-up period of 10.4 ± 7.1 months.

Table 1 Demographic data and clinical characteristics of the patients

Age, years, mean ± SD	64.8 ± 16.9
Gender, *n* (%)	
Male	8 (66.7)
Female	4 (33.3)
BMI, kg/m^2, mean ± SD	25.6 ± 3.7
ASA score, *n* (%)	
I	2 (16.6)
II	8 (66.7)
III	2 (16.6)
Previous abdominal surgery, *n* (%)	1 (8.3)
Tumor localization, *n* (%)	
Distal ascending colon	6 (50.0)
Hepatic flexure	3 (25.0)
Proximal transverse colon	3 (25.0)

BMI body mass index, *ASA* American Society of Anesthesiologists, *SD* standard deviation

Table 2 Operative data and postoperative outcomes

Robot docking time, min, mean ± SD	7.2 ± 3.2
Operating time, min	
Mean ± SD	312.1 ± 93.9
Median (range)	345 (180–420)
Estimated blood loss, ml	
Mean ± SD	110.0 ± 89.9
Median (range)	100 (10–300)
Conversion, *n* (%)	0 (0)
Intraoperative complications, *n* (%)	2 (16.6)
Time to first flatus, days, mean ± SD	3.5 ± 3.2
Time to first bowel movement, days, mean ± SD	3.8 ± 2.2
Time to resume soft diet, days, mean ± SD	3.7 ± 2.1
Length of hospital stay, days, mean ± SD	7.6 ± 4.7
Postoperative complications, *n* (%)	2 (16.6)
Ileus	1
Pulmonary embolism	1
Reoperation, *n*	0
30-day readmission, *n*	0
30-day mortality, *n*	0

SD standard deviation

Discussion

In this report, the key steps of our top down dissection technique in robotic extended right hemicolectomy with CME are described. Our results show that this technique provides a well-controlled access to vascular pedicles at the mesenteric root of transverse colon with minimal blood loss.

Despite the oncologic superiority of CME, concerns have been raised regarding the technical demands of this procedure and the potential for perioperative complications, particularly vascular injuries. These concerns have become common when CME has to be performed laparoscopically [16, 17]. Furthermore, for an extended right hemicolectomy, CME can be considered as a more complex procedure as it requires a clear understanding of the vascular anatomy to complete oncologic dissection. Division of the origin of middle colic vessels at the level of the pancreatic head is an important specific feature of CME with extended right hemicolectomy. Consequently, various surgical strategies have been proposed to safely perform dissection around the middle colic vessels in standard laparoscopy [5, 10, 18–21],

Table 3 Histopathological findings

pT category, *n* (%)	
T_0	0
T_1	0
T_2	3 (25.0)
T_3	3 (25.0)
T_4	6 (50.0)
pN category, *n* (%)	
N_0	7 (58.3)
N_1	3 (25.0)
N_2	2 (16.7)
pTNM stage, *n* (%)	
0	0
I	2 (16.7)
II	6 (50.0)
III	4 (33.3)
Tumor size, cm, mean ± SD	4.6 ± 1.7
Number of harvested lymph nodes	
Mean ± SD	45.2 ± 11.1
Median (range)	43 (31–62)
Lymph node ratio, %	0.3
Specimen length, cm, mean ± SD	37.8 ± 9.9
Proximal resection margin, cm, mean ± SD	12.6 ± 8.1
Distal resection margin, cm, mean ± SD	17.8 ± 8.0
Radial resection margin, cm, mean ± SD	5.1 ± 2.4
Length between vascular tie and tumor, cm, mean ± SD	12.3 ± 4.0
Completeness of CME, *n* (%)	
Mesocolic plane	9 (75.0)
Intramesocolic plane	2 (16.7)
Muscularis propria plane	1 (8.3)

CME complete mesocolic excision, *SD* standard deviation

with the caudal-to-cranial dissection technique as being the most commonly employed strategy.

Although our top down technique shares similar features with the original cranial-to-caudal technique [12, 13], there are several important distinctions between the two. The original cranial-to-caudal technique was performed via laparoscopy whereas we used a robotic approach. Therefore, instead of dissecting the mesocolic vascular structures along the SMV in a full superior-to-inferior manner, we carried out this dissection process in two steps in order to apply this technique to our robotic procedures. In the first step, similar to the original cranial-to-caudal technique, dissection was performed superiorly towards the root of the transverse mesocolon for the central ligation of the middle colic vessels and mobilization of the mesenteric root. For this step, the patient was placed in reverse Trendelenburg and this maneuver helped put the gastrocolic ligament under tension, further facilitating dissection around the gastrocolic trunk. However, after mobilization of the mesenteric root, the transverse mesocolon and omentum piled up and retracted inferiorly, making a full cranial-to-caudal dissection along the SMV cumbersome. Therefore, in the second step, dissection was directed to the ileocolic region and proceeded in a cephalad direction to divide the ileocolic and right colic vascular pedicles. The Trendelenburg position in this step helped retract the transverse mesocolon and omentum out of the operative field, which, in turn, greatly eased the exposure of the SMV. As another modification of the original approach, we did not mobilize the right colon laterally or take down the hepatic flexure before transecting the bowel, but performed these steps according to the principles of Turnbull's no-touch isolation technique [15]. The no-touch technique, which involves division of lymphovascular pedicles and closure of the bowel lumen prior to mobilization of the colon, is thought to reduce the risk of metastatic spread [4, 15, 18].

In our experience, while the requirement for patient repositioning with re-docking of the robot seem to be a drawback in terms of prolonging operative time, this step is deemed necessary to better expose the surgical trunk and thus facilitate repair if vascular injury occurs. With better exposure, the vascular injury at the origin of a jejunal branch of the SMV in 2 patients was repaired readily with no technical difficulties. Use of an integrated table motion for the robot may avoid robot re-docking and reduce operative time.

Robotic surgery has gained a wide acceptance in the field of colorectal surgery because its advantages overcome the limitations of laparoscopy. However, the uptake of robotic surgery for right-sided CME procedures has been relatively slow, and to our knowledge, there are only 4 reports available on the use of a robot in this procedure [7, 8, 22, 23]. Currently, we routinely perform CME for colon cancer. In our multimedia article published prior to the adoption of the top down technique [8] and in the other studies the dissection is carried out in a medial-to-lateral fashion proceeding cephalad along the ventral aspect of the superior mesenteric vein. We later switched to the top down technique when performing extended right hemicolectomy for tumors localized in the distal ascending colon, hepatic flexure or proximal transverse colon.

Whatever the technique used in colon cancer surgery, it should be safe and provide an accurate oncologic resection based on the principles of CME. In the present study, all the operations were completed successfully with no conversions. The mesocolic plane was achieved in the majority of patients (75%). The number of harvested lymph nodes (mean 45.2) was higher than in studies on larger open or laparoscopic series for an extended right hemicolectomy [6, 21, 24]. This data, however, should be considered as preliminary due to the small number of patients in our series.

Conclusions

We believe the top down technique to be useful for early identification and control of the gastrocolic trunk and middle colic vessels during robotic CME with extended right hemicolectomy. Further analyses of larger numbers of patients are essential to evaluate the feasibility and oncologic validity of this technique.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in this study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments.

Informed consent Informed consent was obtained from all patients.

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