Feasibility and efficacy of laparoscopic radical right hemicolecotony with complete mesocolic excision using an ‘artery-first’ approach

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Abstract

Background: According to previous guidelines, the lymph nodes around the right side of the superior mesenteric artery (SMA) should be dissected and removed en bloc. However, due to the technical challenge and the risk of complications, most surgeons perform the dissection along the axis of the superior mesenteric vein (SMV). Herein, we described an ‘artery-first’ approach for laparoscopic radical extended right hemicolecotony with complete mesocolic excision (CME).

Methods: A total of 22 cases were collected from January to October 2016. The right side of the SMA and SMV were exposed and separated, and the No. 203, No. 213 and No. 223 lymph nodes were dissected en bloc. Toldt’s fascia was dissected and expanded laterally to the ascending colon, cranial to the pancreas head. The caudal root of the mesentery and lateral attachments of the ascending colon were completely mobilized.

Results: There were 9 male and 13 female patients, with a mean age of 63.1 (range, 39–83) years and the mean body mass index was 24.6 (range, 18.3–37.7) kg/m². The mean operative time was 192.5 (range, 145–240) minutes and the mean intra-operative blood loss was 55.0 (range, 10–300) ml. The mean number of harvested lymph nodes was 27.0 (range, 13–55) and the time to flatus and hospital stay were 35.0 (range, 26–120) hours and 7.5 (range, 5–20) days, respectively. Minor complications occurred in two patients and no post-operative death was observed.

Conclusions: The preliminary results suggest that the reported approach may be a feasible and safe procedure that is more in accordance with the principles of CME.

Key words: Laparoscopic right hemicolecotony; complete mesocolic excision; ‘artery-first’ approach

Introduction

Since complete mesocolic excision (CME) was proposed in 2009 by Hohenberger et al. [1] to remove the affected colon and the main lymphatic drainage in an intact envelope, it has gradually become accepted as the standard operation for the radical resection of right-sided colon cancer. The core of CME is the sharp
dissection of the visceral plane from the retroperitoneal one, aiming to avoid any breaching of the visceral fascia layer, which potentially may lead to tumor spread within the peritoneal cavity. With this procedure, the origin of the colonic arteries can be well exposed and tied centrally at their origin to ensure maximal harvest of the regional lymph nodes. The concept of CME is the same as that of standard D3 cleaning [2].

According to the mesenteric lymph node drainage rules and the Japanese Classification of Colorectal Carcinoma guidelines [2], radical surgery of right-sided colon cancer requires D3 cleaning of the lymph nodes at the root of the colonic vessels, requiring exposure of the superior mesenteric artery (SMA) and dissection of its right regional lymph nodes. The principle of lymph node dissection is similar to that applied for gastric and rectal cancer or other gastrointestinal tumors. However, because of the difficulty in D3 cleaning of the root nodes of SMA and possible complications such as severe diarrhea and chylous fistula, most surgeons locate the internal boundary of D3 cleaning of right-sided colon cancer to the superior mesenteric vein (SMV) [3–5]. To investigate the safety and validity of D3 cleaning to the internal boundary line of the SMA, we performed laparoscopic right hemicolectomy for right-sided colon carcinoma using the ‘artery-first approach’ method.

Patients and methods

Case selection

From January to October 2016, we performed laparoscopic right hemicolectomy for 22 consecutive cases at the Department of Gastrointestinal Surgery in Guangdong Province Hospital of Traditional Chinese Medicine. Patient inclusion criteria were as follows: (i) right-sided colon cancer was confirmed by pre-operative examination and the advanced tumor was resectable without distant metastasis; (ii) pre-operative multidisciplinary treatment assessment suggested no significant contraindications for surgery; and (iii) laparoscopic surgery. Exclusion criteria were: (i) emergency surgery for various reasons; (ii) obstruction, including obstruction treated with enteral stenting; (iii) past history of abdominal surgery; (iv) right hemicolectomy not performed during the operation for various reasons other than conversion; and (v) pre-operative radiotherapy or chemotherapy. Institutional review board approval was obtained prior to initiating the study.

Surgical procedure

After routine pre-operative preparation, the patient was placed in the supine straddle position and changed to the lateral position with the affected side up according to the situation during the operation at any time. The pneumoperitoneum pressure was approximately 12 mmHg. A 12-mm trocar was placed 2 cm below the umbilicus. Before the next step, laparoscopic exploration was performed to determine whether the tumor was resectable. In the junction of the horizontal line (2 cm above the umbilicus) and the left anterior axillary line, a 15-mm main operative trocar was inserted and an auxiliary 5-mm trocar was placed at the anti-McBurney point. The first assistant placed two 5-mm trocars at the junction of the right anterior axillary line and the horizontal line (3 cm below the lower ribs) and the McBurney point. The standing positions of the operator, first assistant and mirror helper were the straddle position and right side and left side of the patient, respectively.

Figure 1. Opening the anterior mesenteric lobe at the junction of the small intestinal mesentery and the right mesocolon. SMV, superior mesenteric vein.

Figure 2. Incising the retroperitoneum in front of the superior mesenteric arterial midline. SMA, superior mesenteric artery; SMV, superior mesenteric vein.

Following laparoscopic exploration, the anterior lobe of the right-sided mesocolon was cut through at the natural fold between the right-sided mesocolon and small-intestine mesentery, entering the posterior space of the right mesentery (Figure 1). Along the SMA in the caudal-to-cranial direction, we opened the visceral peritoneum and exposed the root of the ileocolic artery (ICA) and caudal SMA. Along the projection of the SMA, we continued to open the visceral peritoneum and the sheath of the SMA, and we bared the right-sided wall of the SMA, right colonic artery (RCA) and middle colonic artery (MCA). Next, we ligated and dissected at the root of the RCA and right branch of the MCA for dissection of lymph nodes Nos 213 and 223 (Figure 2). On the right side of the SMA, when the SMV sheath was opened, the main trunk, ileocolic vein (ICV), Henle’s trunk and middle colonic vein (MCV) were bared. The roots were ligated and dissected, and the Nos 203, 213 and 223 lymph nodes were removed en bloc (Figure 3).

On the right side of the SMV, we sharply dissected the posterior lobe of the right mesocolon through blunt and sharp separation to expand the posterior space of the right mesocolon. The outward side was to the lateral peritoneal reflexion, and the head side was to the lower edge of the liver and the root of the transverse mesocolon. Expanding the anterior pancreaticoduodenal space was halted before the superior anterior pancreaticoduodenal vein (SAPDV) divides from Henle’s trunk into the anterior space of the pancreas to avoid damaging the SAPDV. Then, we finely dissected Henle’s trunk and its branches and cut off the accessory right colic vein to enter the posterior space of the transverse mesocolon (Figure 4). Finally, the right mesocolon and the right part of the transverse mesocolon were completely freed.
Along the vascular arch of the stomach, we interrupted the 2/3 right side of the gastrocolic ligament and transected the anterior lobe of the transverse mesocolon, which was close to the lower edge of the liver, and completely freed the hepatic flexure (Figure 5). Along the caudal side of the right-sided colon, after lifting the mesenteric root of the small intestine, we opened the ‘membranous bridge’ between the mesentery of the small intestine and the retroperitoneum, the right mesocolon and the lateral peritoneum. After entering the space of the Toldt’s fascia and continuing to the medial space, the right-sided colon and its mesocolon were completely freed.

After en bloc resection of the right 1/3 transverse colon, ascending colon, cecum, 15-cm distal ileum and their mesocolon and omentum, the terminal ileum and left transverse colon were joined via side-to-side anastomosis. In the upper or surrounding areas of the SMA and SMV, the lymphatic vessels were blocked with biological glue to prevent lymphatic leakage (Figure 6). The peritoneal cavity was washed and the bleeding foci were detected by laparoscopy. The residual bowel was arranged and the hepatorenal recess was drained. In the management of surgical specimens, we numbered the left-sided lymph nodes of the middle line of the SMV as No. D3a and sent them for pathological examination separately.

Post-operative indicators

We recorded the post-operative pathological results, number of lymph node dissections, post-operative exhaust time, post-operative abdominal drainage volume, post-operative short-term complications, post-operative hospital stay and post-operative 30-day re-hospitalization rate and mortality. Post-operative pathological staging was adopted according to the 7th edition of the AJCC TNM staging system.

Results

Baseline characteristics

Of the 22 patients, 9 were male and 13 were female. The mean age was 63.1 (range, 39–83) years and the mean body mass index (BMI) was 24.6 (range, 18.3–37.7) kg/m². The tumor was located at the ileocecal portion in 7 cases and in the ascending colon in 15. According to the pre-operative clinical staging, there were 3 cases of stage I, 13 stage II and 6 stage III (Table 1).

Operative characteristics

The mean operation time was 192.5 (range, 145–240) minutes and the mean intra-operative blood loss was 55.0 (range, 10–300) ml (Table 1). One case of operative bleeding for 300 ml was caused by injury to the root of the ICA; a 6–0 vascular suture was used to repair the damaged vascular wall under laparoscopy. Another case involved injury to the anterior superior pancreaticoduodenal vein; a vascular clamp was used to stop the bleeding. Subcutaneous emphysema and hypercapnia occurred in one patient and the operation was successfully completed after closure of the peritoneal puncture hole with a hernia needle. During the operation, three cases of lymphatic leakage were detected in the lymphatic vessels between the SMV and SMA, which were all successfully blocked using biological glue. No case required conversion.
Post-operative pathological characteristics

The pathological types were as follows: 2 cases of low differentiated adenocarcinoma, 17 cases of moderately differentiated adenocarcinoma, 1 case of highly differentiated adenocarcinoma, and 2 cases of mucous adenocarcinoma. Regarding pathological stage, there were 2 cases of stage I, 17 cases of stage II and 3 cases of stage III. Overall, 75.4% of cases were in accordance with pre-operative clinical staging. The mean number of lymph node dissections was 27.0 (range, 13–55) and the mean number of NO.D3a lymph nodes was 3.5 (range, 0–8). There was one case of metastasis of the NO.D3a lymph nodes (Table 1).

Post-operative short-term outcomes

The mean time to flatus was 35.0 (range, 26–120) hours and the mean hospitalization time was 7.5 (5–20) days. The mean abdominal drainage volume was 766 ml after the operation and the mean indwelling time of the abdominal drainage tube was 5 days. The number of defecations was increased in one patient, being 7–11 times per day, which gradually relieved after oral administration of droperidine for 3 days; the number of defecations decreased to fewer than three times per day following withdrawal of droperidine. Post-operative abdominal infection occurred in one patient. After treatment, the patient recovered and was discharged. The total post-operative complication rate was 9.1% (2/22) and there were no 30-day re-hospitalized patients and no mortality (Table 1). There was no recurrence and no deaths during the 1-year follow-up period.

Discussion

Total mesorectal excision (TME) for rectal cancer was proposed by Heald and Ryall [6] in 1986 and this concept of standardized quality control of rectal cancer has since been widely promoted and applied. The therapeutic effect of rectal cancer has significantly improved patient outcomes. By contrast, advances in colon cancer surgery have been slow. Until Hohenberger et al. [1, 7] put forward the concept of CME in 2009, the quality standard of radical operation of colon cancer has a better evaluation method. Studies have shown that the CME procedure can effectively reduce the 5-year recurrence rate and increase the 5-year survival rate [8, 9]. The main characteristics of the CME operation are as follows: (i) ligation at the root of nutrient vessels to achieve the greatest lymph node dissection; (ii) sharp separation to detect and maintain the anatomical surface from embryonic development to ensure the smooth and complete dissection of the visceral fascia. According to the CME operation principle, the medial boundary of the D3 lymph node dissection in right-sided colon cancer should be in the midline of the SMA [10–12]. However, the medial boundary of the right colon cancer resection and lymph node dissection had been the subject to debate in many previous studies: should it be at the SMA, the SMV or the line between the two vessels? There has been no consensus on this issue. Therefore, it is necessary to establish a standard CME surgical procedure for the right half of the colon to improve treatment efficacy.

Following the process of the colonic mesangial embryonic development and lymph node drainage rule, the drainage lymph nodes of right-sided colon are distributed around the blood-supply arteries [13]. The scope of operation should be guided by the arteries and lymph node dissection should be performed at the root of the perfusion artery [14, 15]. In 1977, according to the Japanese Society of Colorectal Cancer, the drainage lymph nodes of the colon were numbered, with the lymph nodes of the root of the ICA, RCA and MCA being numbered Nos 203, 213 and 223, the focus of D3 cleaning [2]. The rate of third-station lymph node metastasis in right-sided colon cancer has been reported as 0–5.8% [16, 17] and 11% [18]. Therefore, the Japanese colorectal surgery guidelines stipulate that the D3 clearance of right-sided colon cancer requires the baring and ligation of the root of the perfusion vessels and the en bloc dissection of peripheral lymph nodes [2]. According to these guidelines, similarly to the principle of lymph node dissection for D2 lymph node dissection of gastric cancer and the TME procedure for rectal cancer, the medial border in CME for right-sided colon cancer must reach the median line of the SMA.

Many surgeons in Western or Eastern countries follow this principle [5, 14, 19]. However, baring of the SMA and cleaning of its peripheral lymph nodes inevitably damage some autonomic nerves of the mesentery, which can lead to severe post-operative diarrhea and gastrointestinal dysfunction, and increase the risk of lymphatic leakage. A study from Japan showed that the lymphatic drainage in the right-sided colon rarely drained to the left side of the anterior surface of the SMV; thus, regardless
of whether the SMA was on the left side or behind the SMV, there was no need to bare the SMA [20]. Therefore, most surgeons continue to use the SMV as the medial line in right-sided colon cancer surgery [1]. Obviously, this practice is not consistent with the principal of colonic lymphatic drainage or the protocols of lymph node dissection of digestive tract tumors such as gastric cancer and rectal cancer. In addition, studies have shown that patients with stage II colon cancer, including those without lymph node metastasis, can benefit from enlarged lymph node dissection [21, 22].

We believe that CME in right colon surgery should remove the lymph nodes at the roots of the ICA, RCA and MCA, with the SMA as the middle line, consistently with the principle of lymph node drainage and dissection in gastric cancer and rectal cancer. This practice is in accordance with Japanese and European guidelines. Regarding operative safety, only two cases of intra-operative bleeding occurred among the 22 patients and laparoscopic hemostasis was successful. The mean intra-operative blood loss was 55 ml. The key to reducing intra-operative bleeding is to open the sheath of the blood vessel. When the mesogastrial membrane is separated, both sharp and blunt separation are necessary and proper use of an ultrasonic scalpel is required. We found that a notable advantage of the SMA approach is that, when the blood vessel is bare, there are typically no blood vessels crossing the surface of the SMA. By contrast, the SMV typically has blood vessels crossing its surface. Thus, compared with the SMV approach, there is less risk of damage to the blood vessels with the SMA approach.

Many authors have expressed concern that opening the sheath of the SMA can easily damage the autonomic nerve and cause severe post-operative diarrhea [11]. In the present study, there was only one case of gastrointestinal dysfunction (1/22) after the operation, which was relieved after active treatment. Lymphatic leakage occurred in three cases, which was treated with biological glue. The mean post-operative drainage volume was 766 ml and the maximum volume was 2800 ml. Drainage volume peaked on post-operative Day 3 and gradually decreased thereafter; there was no lymphatic leakage. The increased drainage volume might have been due to the large scope of the operation and the leakage and exudation of microtubules in the wound. The indexes of post-operative recovery, such as post-operative exhaust time, number of defecations and duration of hospital stay, were not prolonged. These data suggest that CME performed with SMA as the medial boundary is safe and feasible. Regarding lymph node dissection, 3.5 lymph nodes were removed from the left side of the SMV and 1 lymph node was positive. The lymph node dissection and radical degree of the operation were effectively improved, which is expected to improve the prognosis of the patients.

Conclusion

CME operation with SMA as the medial boundary, in accordance with the anatomy of the right mesocolon and the pattern of lymph node drainage as well as European and Japanese guidelines, may become the standard operation for right-sided colon cancer and improve patient prognosis. Our study provides preliminary evidence that the ‘artery-first’ procedure can achieve radical tumor resection of the tumor without significantly increasing operative risks. The procedure is feasible and safe. Larger samples and multicenter, randomized-controlled clinical trials are needed to verify the safety of this procedure and improve the treatment of colon cancer.

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Conflict of interest

None declared.

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